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Status Review of Gila Chub, *Gila intermedia,* in the United States and Mexico

by

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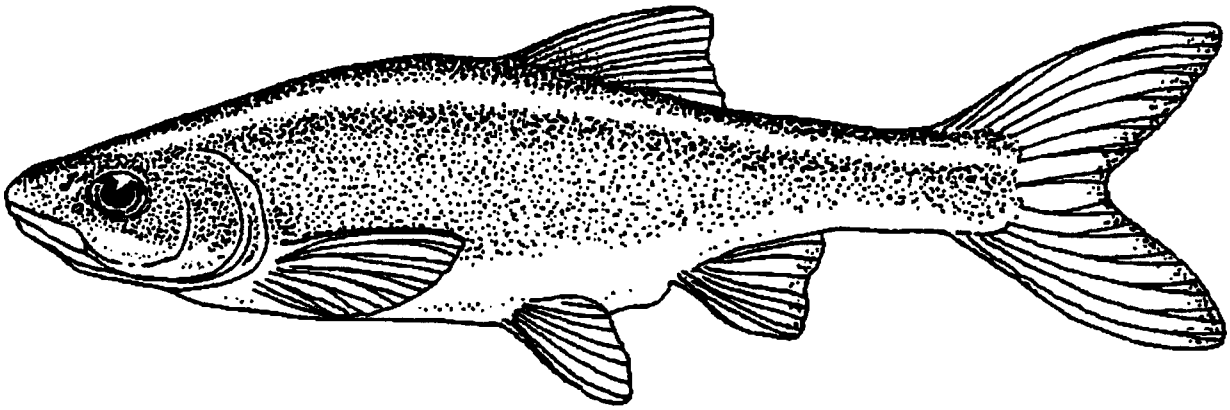

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Introduction

The Gila chub, *Gila intermedia,* known as charalito del Gila in Mexico, is a member of the minnow family Cyprinidae, and one of five species of fishes in the genus endemic to the Colorado River basin. The genus, *Gila,* is widespread throughout western North America (Hubbs 1940, 1941; Miller 1946). Gila chub was a candidate for federal listing as threatened (USFWS 1983). It is currently state listed as threatened in Arizona (AGFD 1988) and was listed in New Mexico as a Group I endangered species in 1975, but they are now considered extirpated in that state (Sublette et al. 1990; Minckley 1991).

Comprehensive knowledge about the historic distribution, abundance, life history, taxonomy, current distribution, past declines in abundance and current status of this species is fairly limited. The U.S. Fish and Wildlife Service (FWS) funded this review in order to obtain a summary of the ecology, biology and past and current distribution of Gila chub in order to assess the status of this species across its range, as it is currently known. This information is necessary to determine the need for protection and management of the species.

Methods

MAPPING AND REPORTING METHODS

Many abbreviations for agencies, organizations, projects, programs, and fishes are used throughout this report. Appendix A provides a complete listing of the abbreviations used.

Land ownership maps were compiled by AGFD HDMS specialists, and provided separately in a 97 x 81 cm (38 x 32 in) binder. Maps were constructed for streams suspected or known to currently contain Gila chub. Maps were not produced for sites where Gila chubs were known to be extirpated prior to this review. End points for each stream reach were selected based on estimated reach of perennial flow, or known or estimated distribution of Gila chub. Each map contains land ownership status and area (in acres) for a buffer zone one mile wide on either side of the selected reach. Land ownership statistics were calculated by HDMS based on the ASLD land ownership database. Township, range, and section lines were included (when available) to aid in accurate location of sample sites. Information currently available from ASLD on active/inactive mine locations was also included on each map to aid in identifying land uses.

Historic and recent collections were identified on each map where sample locations could be determined from available information. The information available for most historical (museum) collections was inadequate to accurately locate the collection sites on the maps.

Stream-specific Gila chub status and distribution information was compiled from a wide variety of sources: published literature, unpublished (gray) reports and manuscripts, personal communications, museum records, agency reports, agency databases, and field observations. Information received from personal communications are cited as "pers. comm."; contact information for each source is listed in Appendix B. Land and water uses were determined based on field observations and personal communications with land managers and private land owners.

The following museums were queried regarding their fish collections: Arizona State University, Museum of Fishes (ASU), University of Michigan Museum of Zoology (UMMZ), Smithsonian Museum of Natural History (SMNH), Museum of Southwestern Biology at New Mexico State University, Albuquerque, New Mwxico (MSB) and Tulane Museum of Natural History at Tulane University, Belle Chasse, Louisiana (TMNH). TMNH could not provide information on their fish collections. Many museum records do not identify possible Gila chub specimens as *G. intermedia*. It was not feasible to physically verify the identification of all specimens at all museums. Therefore, specimens from stream reaches known to contain Gila chub (Minckley 1973; Rinne 1976; DeMarais 1986, 1992) were considered as *G. intermedia*. Where possible, specific collection localities for museum records were referenced in the stream-specific collection tables (Appendix C) and by corresponding numbers placed on the stream-specific Land Ownership Maps. Numbering for each mapped collection locality was not in a sequential order due to methods used by HDMS. Therefore, within the collection summary tables and corresponding Land Ownership Maps, reference numbers may appear out of sequence. This same methodology applies to Gila chub field collection records from the NFDB and other state, federal, and private agency survey reports for which specimens were not found in any museums.

SURVEY METHODS

Field surveys for this project were conducted at locations where additional information was deemed necessary to adequately assess the current status of Gila chub and funding was adequate to conduct such surveys. Surveys consisted of capturing fishes using the most appropriate methods (either a Smith-Root backpack shocker or variable sized 1/8 inch mesh seines) to determine species composition and qualitative abundance of resident species. Total lengths of randomly selected fish were recorded on field data sheets, which are on file at the Arizona Game and Fish Department.

Sample stations were selected based on several factors: need for current information on distribution of Gila chub at a particular site, presence of surface water, and access and time/budget constraints. Each station was sampled for a minimum length of 35 to 60 times the average width to increase the chance of capturing rare species, as recommended by Lyons (1992) and Paller (1995). Notes were taken on general habitat condition, land and water uses, and land management impacts observed in the areas surveyed. Also measured were: temperature, pH, conductivity, and dissolved oxygen. Photographs of sample sites were taken and are on file at AGFD, Native Fish Program.

A sub-sample of *Gila* from each collection locality was preserved as voucher specimens and accessioned into the ASU Collection of Fishes. For all *Gila* preserved, measurements of head length (hi) and least depth of caudal peduncle (pd) were taken with Vernier calipers. Calculations were made of hl/cp ratio (Minckley 1973). Measurements were taken as soon as possible following preservation to minimize effects of specimen shrinkage. Meristic counts (dorsal and anal fin rays and lateral line scales) were done following conventions in Hubbs and Lagler (1958).

METHODS USED TO DESCRIBE POPULATION STATUS

Populations of Gila chub were placed into one of four categories based on the current status of those populations. Due to a general lack of quantitative data on populations, qualitative measures were used as follows:

Stable-Secure	**Gila chubs are common, data over last 5-10 years show a stable reproducing population, no impacts from nonnatives (predatory species), no current or future land use threats were identified.**
Stable-Threatened	**Gila chubs are common to uncommon, potential threats by nonnatives exist, limited habitat altering land and water uses were identified and/or lack of recruitment was detected within the population.**
Unstable-Threatened	**Gila chubs are rare, have limited distribution, predatory or competitive nonnatives are present and/or habitat modified or threatened.**
Extirpated	**Gila chubs are no longer found within the system.**
Unknown	**Lack of data precludes determination of status.**

Results

TAXONOMY

Baird and Girard (1854:28) published the original description for Gila chub as *Gila gibbosa.* Following the original description, several generic and specific names were applied over the years to the species, making for a chaotic nomenclatural history:

***Gila gibbosa* (Baird and Girard 1854:28: original description, Rio Santa Cruz, Arizona)**
***Tigoma intermedia* (Girard 1856: original description, Rio San Pedro, Arizona)**

Tigoma gibbosa (Girard 1856, 1859; Jordon et al. 1930: Rio Gila, Arizona)
Gila nigra (Cope, in Cope and Yarrow 1875: original description, Ash Creek and San Carlos, Arizona)
Squalius intermedius (Jordon and Gilbert 1883)
Squalius niger (Jordon and Gilbert 1883)
Squalius lemmoni (Smith 1884: original description, Rillito Creek, near Tucson, Arizona)
Leuciscus intermedius (Evermann and Rutter 1895: Rio San Pedro; Gilbert and Scofield 1898; Meek 1904)
Leuciscus niger (Jordon and Evermann 1896: Rio Gila)
Richardsonius gibbosus (Snyder 1915)
Gila robusta intennedia (Miller 1945, 1946, 1961; LaRivers 1962; Beckman 1963; Sigler and Miller 1963;Uyeno and Miller 1965; Barber and Minckley 1966; Miller and Lowe 1967;Cole 1968; Minckley and Alger 1968; Minckley 1969)
Gila intermedia (Koehn 1965; Minckley and Deacon 1968; Rime and Minckley 1970; Stout et al. 1970; Minckley 1971, 1973; Rinne 1976; Minckley et al. 1986).

The specific epithet *"gibbosa"* was the first name applied to specimens collected from the Rio Santa Cruz in 1851 by J.H. Clark (Baird and Girard 1854). It became invalid following a later synonymization that was an erroneous homonym (Rinne 1969, 1976). Therefore, the officially recognized original description is *Tigoma intermedia* (Girard 1856). Type specimens were collected from the Rio San Pedro in 1851 by J.H. Clark.

Some stability was accorded the species after Miller (1945) placed it as *Gila robusta intermedia,* a subspecies of *Gila robusta* Baird and Girard. This interpretation was followed for more than 20 years. It was later re-elevated to full species status as *Gila intermedia* (Rime and Minckley 1970; Minckley 1973; Rime 1976; Minckley et al. 1986) although not universally accepted. For example, the American Fisheries Society (Robins et al. 1980) did not recognize it as a full species. However, consensus appears to have been achieved following recognition of Gila chub as *Gila intermedia* by the current edition of that same publication (Robins et al. 1991). The primary reasons for species status are morphological differences between *G. robusta* and *G. intermedia* and their evolutionary and current continuation as independent contiguous populations (DeMarais 1986, 1995).

Taxonomic Status of Fishes in the Genus *Gila*

Rinne (1969, 1976) conducted the first comprehensive study of the taxonomic relationship between *G. robusta* and *G. intermedia* that supported recognition of both species and rejected the concept of "ecological subspecies." Rinne (1969, 1976) also recognized the presence of populations belonging to two subspecies of *G. robusta* in the lower Colorado River basin, G. *r. robusta* and *G. r. grahami.* DeMarais (1995) supported continued recognition of *G. intermedia* with the following arguments: 1) phenotypic extremes between *G. intermedia* and *G. robusta* are widely divergent and each possesses many morphologically uniform populations; 2) the geographic distributions of both species is an overlapping mosaic, therefore subspecies status for *G. intennedia* is inappropriate under traditional geographic criteria; and 3) contiguous

populations of *G. intermedia* and *G. robusta* show no evidence of ongoing genetic exchange, and maintain their evolutionary independence. DeMarais (1986, 1992) further elaborates on these findings.

Contrary to Rinne's (1969, 1976) designation of *G. r. grahami* populations, DeMarais (1986, 1992, 1995) identified those populations as being phenotypically intermediate between *G. robusta* and *G. intermedia* and the result of ancient introgressive hybridization between the two. Although Dowling and DeMarais (1993) documented the widespread occurrence of ancient hybridization among several other *Gila* species, DeMarais (1995) stated that the use of molecular characters from *G. intermedia, G. robusta* and phenotypically intermediate populations neither supports nor refutes the hybrid origin of the latter. DeMarais (1995) did not support recognition of *G. r. grahami as* a valid taxon, and recommends that they be referred to as *G. robusta.* A more accurate, and perhaps more appropriate, way of discussing *G. r. grahami* populations is to refer to them as phenotypically intermediate between *G. robusta* and *G. intermedia.* Thus, populations of *Gila* formerly designated as *G. r. grahami* or those which were formerly found to exhibit phenotypic characteristics intermediate between *G. intermedia* and *G. robusta* are now considered to be roundtail chub, *Gila robusta,* for the purposes of this report, but may still be referred to as "grahami" when discussing previous reports or collections. Phenotypic intermediates inhabit the middle and upper Gila River basin. A summary of taxonomic nomenclature assigned to populations of "grahami" by several authors and museums and nomenclature followed in this report is provided in Table 1.

HISTORIC DISTRIBUTION

***Gila* species are known from mid-Miocene to present (Miller 1965; Uyeno and Miller 1965; Lugaski 1977; Smith and Miller 1986). Species similar, if not identical to, roundtail chub *(Gila robusta,* Baird and Girard 1853a) were present in late Pliocene (Uyeno and Miller 1963, 1965). Probable evolutionary events involve habitation of the lower Colorado River basin by a form of *G. robusta* derived from the north in early stages of drainage integration with the Colorado Plateau; a second form of *Gila (G. intermedia* or its ancestor) invading from the south, and inhabiting waters south and west of the Mogollon Highlands; completion of internal integration of the Gila basin allowing invasion of an aggressive, larger-river population of *G. robusta* into areas inhabited by the previously mentioned chubs; the occurrence of ecological adjustments and displacements, plus intergradation of the two forms of *G. robusta,* until complementary distributions were attained (Rinne 1969).**

The historic range of Gila chub likely included suitable habitat throughout the entire Gila River basin (Minckley 1973; Sublette et al. 1990) with the exception of the Salt River drainage above Roosevelt Lake (DeMarais 1995). Gila chub is known to have been present in approximately 30 rivers, streams, and spring-fed tributaries throughout the Gila River basin in New Mexico, northern Sonora, Mexico and central and particularly southeastern Arizona, (Miller and Lowe 1967; Rinne and Minckley 1970; Minckley 1973; Rinne 1976; DeMarais 1986; Bestgen and Propst 1989).

Table 1. Taxonomic designations by authors for *Gila* populations morphologically intermediate between *G. intermedia* (GIIN) and *G. robusta* (GIRO). Species code abbreviations are defined in Appendix A.

Location	Minckley (1973)	Rinne (1976) '	DeMarais (1986)[2]	Current Designation
Aravaipa Creek	"grahami"	"grahami"	GIRO	GIRO
Beaver Creek		"grahami"	GIRO	GIRO
Eagle Creek, upper Eagle Creek, lower	"grahami"	"grahami"	GIIN, GIRO	GIIN GIRO
East Verde River	"grahami"	"grahami"	intermediate	GIRO
Fossil Creek	"grahami"	"grahami"	GIRO	GIRO
Fossil Springs			intermediate	GIRO
Gila R. above San Carlos Reservoir	"grahami"	"grahami"	intermediate	GIRO
Gila R. below San Carlos Reservoir	GIRO	"grahami"	GIRO	GIRO
Oak Creek	GIRO GIIN	GIRO GIIN		GIRO (possibly some GIIN as transients)
Rye Creek			intermediate	GIRO
Salt River	GIRO	GIRO	intermediate	GIRO
San Francisco River (main stream only)	- -	"grahami"		GIRO
San Pedro River (main stream only)	"grahami" and GIIN	GIIN (headwaters), and "grahami"		GIIN (headwaters) GIRO (lower)
Tonto Creek	"grahami" and GIRO	"grahami"	intermediate	GIRO
W Clear Creek (upper) (lower)			intermediate GIRO	GIRO

Rinne (1976) reported "grahami" in the Little Colorado River basin in East, Clear and Chevelon Creeks, and possibly the Little Colorado River. However, DeMarais (1986) identified chubs from the entire Little Colorado River Drainage as GIRO.

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

In Arizona, the species is known to have inhabited main stream and/or tributaries of the Gila, Salt, Verde, Santa Cruz, San Pedro, San Simon, San Francisco and Agua Fria river drainages (Fig. 1). Habitats occupied by Gila chub included suitable cienegas and small tributaries (Minckley 1969; Stout et al. 1970), along with artificial habitats such as the Buckeye Canal (Rinne 1969). The northernmost documented location of Gila chub was in the upper Verde River system below the Mogollon Rim, in Big Chino Wash and Williamson Valley Wash (Rinne 1969, 1976).

A strong correlation exists between the historic distribution of cienega habitats discussed by Hendrickson and Minckley (1984) and the known distribution of Gila chub in the San Pedro, Santa Cruz, and San Simon River basins. The loss of many of those habitats, due to arroyo cutting in the late 1800s and early 1900s, likely resulted in loss of undocumented Gila chub populations.

In western New Mexico, the species formerly inhabited the Gila River basin in Apache Creek, Catron County; Duck Creek, Grant County; and San Simon Cienega, Hidalgo County (Rinne 1969, 1976; Hubbard et al. 1979; Bestgen and Propst 1989; Sublette et al. 1990). Gila chubs were collected in the San Francisco River, New Mexico in 1872, but the exact location remains unknown (Sublette et al. 1990).

Gila chub likely inhabited the San Pedro River headwaters and the Santa Cruz River in northern Sonora, Mexico. J.H. Clark's collection, in 1851, of the type specimen in the Rio Santa Cruz occurred in what is now Sonora (Varela-Romero et al. 1992). However, no other published historic records (pre-1990) indicate Gila chub presence in Mexico. In August 1990, Gila chubs were discovered in Mexico at Cienega los Fresnos, a tributary to the San Pedro River, in Sonora, Mexico (Varela-Romero et al. 1992). Gila chubs were collected again from Cienega los Fresnos in 1991. During that survey they were also collected from Cienega la Cienegita (Gori 1993). Both populations were associated with spring-fed cienegas isolated from the San Pedro River by extensive dry stretches of stream.

DeMarais (1995) stated that G. *intermedia* could plausibly occur in the upper Bill Williams drainage. Relatively gentle divides separate it from streams of the upper Verde River and there exists the potential for transfer of G. *intermedia* via stream capture. Extant or recent populations of Gila chub in extreme headwaters of the Verde (Williamson and Chino Valleys) document the potential for natural transfer into the Bill Williams system. The occurrence in the Bill Williams of characteristic Gila basin species such as longfin dace (*Agosia chrysogaster*), Gila sucker (*Catostomus insignis*), and possibly Gila mountain sucker (*Pantosteus clarki*) may reflect such a phenomenon.

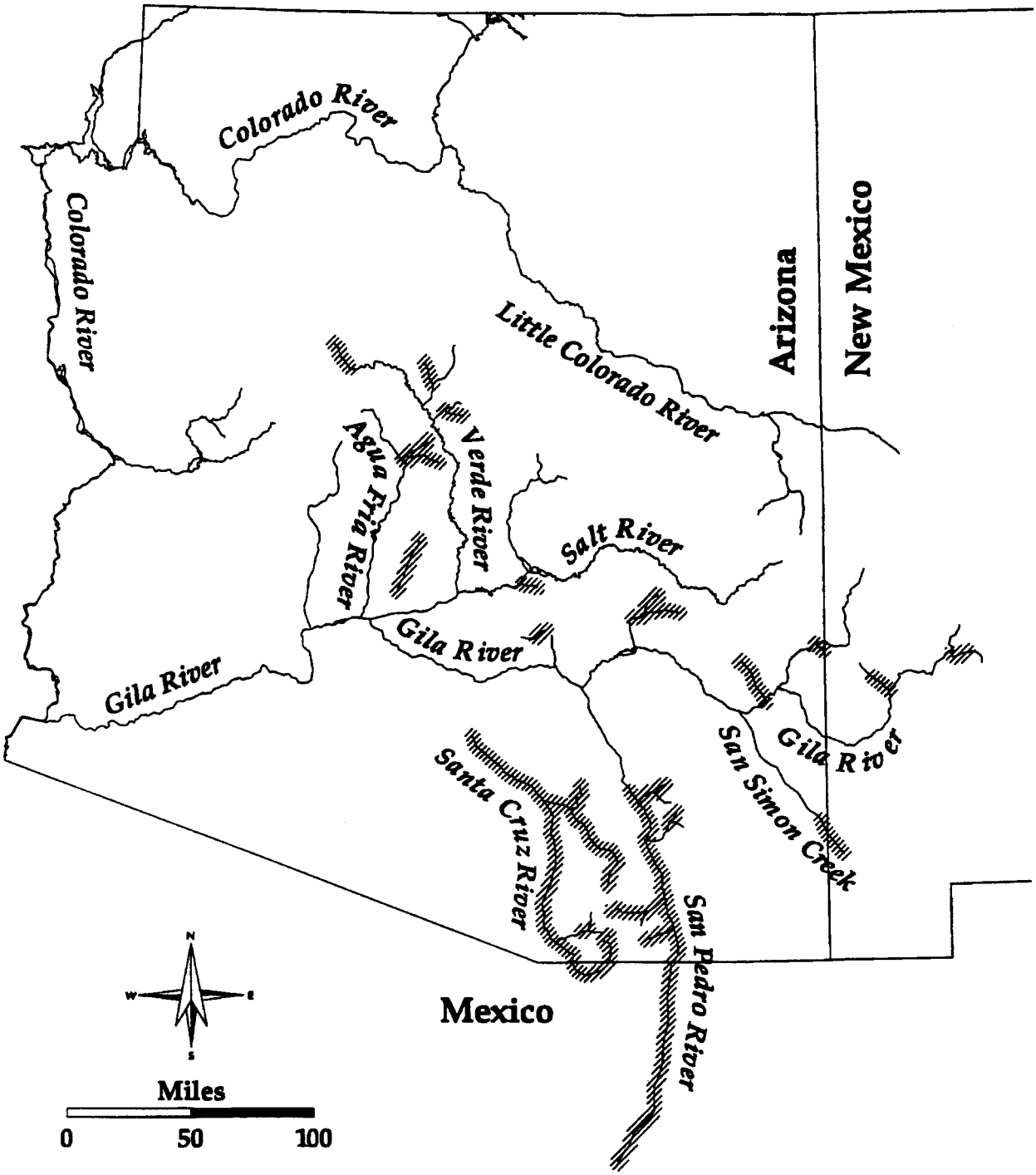

Figure 1. Historic distribution of Gila chub.

LIFE HISTORY

Description of the Species

Descriptions for roundtail chub, both *G. r. robusta* and "grahami", are included for ease of comparison.

The Gila chub is small-finned, deep-bodied, chubby (chunky), and darkly colored (sometimes lighter on belly; diffuse lateral band(s) are rarely present). Adult males average about 150 mm (6 in) in total length and females can be over 200 mm (8 in). Scales are coarse, large, thick, and broadly imbricate, with basal radii typically present. Lateral-line scales usually number greater than 61 and less than 80. There are usually eight (rarely seven or nine) dorsal and anal fm-rays; pelvic fin-rays typically number eight, but sometimes nine. Head length divided by caudal peduncle depth is 3.0 or less. An abrupt, soft and fatty nuchal hump rarely develops in large females of some populations. Total number of vertebrae ranges between 38 and 45 (usually fewer than 42). Barbels are absent. The pharyngeal arch is similar to *G. robusta,* with teeth in two rows (2, 5-4, 2 with some variation). Both sexes possess breeding **tubercles,** although distribution is less extensive in females. There is no basicaudal spot (Rinne 1969, 1976; Minckley 1969, 1973; DeMarais 1986).

The roundtail chub has a thick (not chubby), less robust body, with light to mottled coloration. Adult body length is highly variable, but typically ranges from 250 to 350 mm (10-14 in). The species is larger-fmned than Gila chub, and scales are smaller, thinner, and slightly imbricate. Basal radii are absent to weakly developed. Lateral-line scales usually number more than 80. Dorsal, anal, and pelvic fin-rays usually number nine. Head length divided by caudal peduncle depth is usually 3.3 to 4.3, but rarely greater than 4.0. A fatty nuchal hump is rarely developed, and if present, scarcely discernible. Total number of vertebrae range from 43 to 49 (Winn and Miller 1954; Rinne 1969).

The morphologically intermediate "grahami" is relatively thick bodied, dark, gray, and commonly shows coloration blotches on dorsal and lateral areas. There are 70 to 90 lateral-line scales (usually 75 to 85); eight or nine anal fin-rays; a mean length of caudal peduncle divided by mean length of head usually less than 0.74; and a mean head length divided by mean caudal peduncle depth almost always less than 3.3 (Rinne 1976).

For purposes of identification, meristic and morphometric correlations suggest that the use of one or two characters, dorsal fm-ray counts and/or ratio of head length to caudal peduncle depth, is adequate for identification of *G. intermedia* relative to *G. robusta* (DeMarais 1995). Additional characters are unlikely to greatly aid identification. Identification of fishes in the field may therefore be possible and nearly as accurate as a more detailed morphometric/meristic analysis. However, keys developed by Rime (1969) and DeMarais (1986) are based on mean measurements within a population and a sufficient sample size is necessary to accurately identify the range af variation within the population. Identification of individual specimens will remain

problematic. A comparison of morphometric measurements and meristic counts for *G. intermedia, G. robusta* and phenotypic intermediates is made in Table 2.

Table 2. Morphometric differences between *Gila intermedia, G. robusta* and "grahami" (Winn and Miller 1954; Rinne 1969; Minckley 1969, 1973; Rinne 1976; Minckley 1991).

CHARACTERISTIC	*Gila intermedia* (Gila chub)	"grahami"	*Gila robusta* (Roundtail chub)
Body shape	Deep-bodied, chubby/chunky	Relatively thick bodied	Thick, not chubby
Average adult body length (total length)	150 mm (127-203 mm; 5-8 in)		250-350 mm (10-14 in)
Color	Dark (possible lighter belly; no black bands)	Dark, gray (some dorsal/lateral blotching)	Light to mottled
Scales	Large, thick, broadly imbricate		Small, thin, slightly imbricate
Basal radii [1]	Usually present		Absent to wealdy developed
Lateral-line scales[2]	> 61 and < 80	70 to 90 (usually 75-85)	Usually ≥ 80
Dorsal fin-rays	8 (rarely 7 or 9)	8 or 9	9
Anal fin-rays [4]	8 (rarely 7)	8 or 9	9 (usually)
Pelvic fin-rays	8 (sometimes 9)	9	9 (usually)
Length of head/depth of caudal peduncle [6]	3.0 (usually)	3.0-3.3 (usually < 3.3)	3.3-4.3 (but rarely > 4.0)
Nuchal hump	Occasional		Rare
Total number vertebrae	38-45 (usually < 42)		43-49
Pharyngeal teeth	2, 5-4, 2		2, 5-4, 2

Rinne (1969) provided these summaries:

' Basal radii: strongly-inscribed in 63% of about 70 GIIN throughout range; weakly developed in 14.6% of 137 GIRO.

[2] Lateral-line scales: 97% of 390 GIIN (77% had <75); 80% of 670 in both GIRO subspecies (96% had >75).

[3] Dorsal fin-rays: 7 or 8 in 94% of GIIN; 9 in 83% GIRO examined.

[4] Anal fin-rays: less reliable characteristic for separating species due to high incidence of 8 rays in "grahami" (about 50%). Counted 7 or 8 in 98% of GIIN; 8 counted for 13% of GIRO examined.

[5] Pelvic fin-rays: 8 or 9 (50:50) in GIIN; >95% GIRO had 9 pelvic fm-fays.

[6] Length of head/depth of caudal peduncle: <3.0 in 83% of GIIN; >3.0 in 87% of GIRO. GIRO is more distinct (>95% above 3.0) from GIIN than is "grahami" (77% more than 3.0)

Ecology

The biology of this species is poorly understood. Current knowledge is gathered from specific populations, but species variation demands further research using a broader sampling base. *Gila intermedia* is morphologically and morphometrically similar to *G. robusta.* Gilbert and Scofield (1898) indicated local sympatry occurred between *G. intermedia* and at least one other *Gila* species in complex Arizona habitats from the Salt River above the Gila River confluence in the Tempe area. And, although *Gila* species are reported as existing in habitat separated by only tens of meters, there are no collection records of *G. intermedia* and other *Gila* species at the same location (Rinne 1969; Minckley 1973, 1985; DeMarais 1986).

Native fishes that have occurred throughout historic range of Gila chub include roundtail chub, loach minnow *(Tiaroga cobitis),* spikedace *(Meda fulgida),* speckled dace *(Rhinichthys osculus),* longfin dace, Sonora sucker, desert sucker, desert pupfish *(Cyprinodon macularius)* and Gila topminnow *(Poeciliopsis o. occidentalis).* Other fishes collected from the Gila River basin that may have been present with transient populations of Gila chub in larger riverine habitats include: woundfin *(Plagopterus argentissimus),* bonytail chub *(Gila elegans),* squawfish *(Ptychocheilus lucius),* flannelmouth sucker *(Catostomus latipinnis)* and razorback sucker *(Xyrauchen texanus).* Yaqui catfish *(ktalurus pricei)* was introduced into Gila chub habitat at Monkey Spring, presumably from the Rio Sonora basin in Sonora, Mexico (Minckley 1973).

Nonnative fishes known from within historic range of Gila chub in the Gila River basin include channel catfish *(ktalurus punctatus),* flathead catfish *(Pylodictis olivaris),* red shiner *(Cyprinella lutrensis),* fathead minnow *(Pimephales promelas),* green sunfish *(Lepomis cyanellus),* largemouth bass *(Micropterus salmoides),* smallmouth bass *(Micropterus dolomieui),* rainbow trout *(Oncorhynchus mykiss),* mosquitofish *(Gambusia affinis),* and carp *(Cyprinus carpio)* (USFWS 1983; Dunsmoor 1993; Young and Bettaso 1994). Other nonnatives collected within the range of Gila chub include: warmouth *(Lepomis gulosus),* bluegill *(Lepomis macrochirus),* yellow bullhead *(Ameiurus natalis),* black bullhead *(Ameiurus melas),* and goldfish *(Carassius auratus)* (AGFD Native Fish Database [NFDB]).

Habitat

Gila chubs commonly inhabit pools in smaller streams, cienegas, and artificial impoundments in central and southern Arizona (Miller 1946; Minckley 1973; Rinne 1975). Habitats occupied by populations of Gila chub exhibit unique physico-chemical characteristics, riparian types, and seasonal parameters (USFWS 1983; Vives 1990). Common riparian plants associated with these populations include willows *(Salix* spp.), tamarisk *(Tamarix* spp.), cottonwoods *(Populus* spp.), seep-willow *(Baccharis glutinosa),* and ash *(Fraxinus* spp.). Typical aquatic vegetation includes watercress *(Nasturtium officianale),* horsetail *(Equisetum* spp.), rushes *(Juncus* spp.), and speedwell *(Veronica anagallis-aquatica)* (Goodwin 1979; USFWS 1983).

Gila chubs are highly secretive, preferring quiet deeper waters, especially pools, or remaining near cover including terrestrial vegetation, boulders, and fallen logs (Minckley 1991). Undercut banks created by overhanging terrestrial vegetation with dense roots growing into pool edges provide ideal cover (Nelson 1993). The species can also survive in larger stream habitats such as the San Carlos River, and artificial habitatas like the Buckeye Canal (Stout et al. 1970; Rinne 1976). Gila chubs interact with spring and small-stream fishes on a regular basis (Meffe 1985), but are usually restricted to deeper waters (Minckley 1973). Adults are often found in deep pools and eddies below areas with swift currents. Young-of-the-year inhabit shallow water among plants or debris while older juveniles use higher velocity stream areas (Minckley 1973, 1991).

Young Gila chubs (total length 25-75 mm; 1-3 in) from Monkey Spring, Santa Cruz County, Arizona (now extirpated) inhabited swifter areas than adults, which used undercut banks and heavily vegetated margins of the spring run (Minckley 1969). Griffith and Tiersch (1989) collected Gila chubs from both riffles and pools in Redfield Canyon, Arizona. Dudley (1995) found that Gila chubs in Sabino Creek, Arizona were highly reclusive in winter, occupying dark, interstitial spaces. Adults were found in deep water with small substrates, but often away from cover. Sub-adults and adults were more active and visible in the summer and were observed farther from cover. Sub-adults were observed more frequently in shallow areas with measurable current as water temperatures increased.

Reproduction

Spawning typically occurs from late spring into summer (Minckley 1973; Griffith and Tiersch 1989; Nelson 1993). Breeding males display deep red or orange coloration on brancheostegal rays and lower cheeks, posterior jowels and paired fin bases; and red ventro-lateral surfaces including the caudal peduncle. Reproductive males also possess yellow to yellow-orange eyes, and the body is blue-black dorsally. Fins of some individuals, especially the larger ones, may be washed with a lemon-yellow coloration (Minckley 1969, Rinne 1969; Rinne and Minckley 1970; Minckley 1973; Rinne 1976). These breeding colors may resemble those of both *G. robusta* and "grahami," but color intensity is greater in *G. intermedia* (Minckley 1969; Rinne 1969; Minckley 1973).

Spawning is most likely sporadic over the reproductive season (Minckley 1991). In a constant temperature spring in the Sonoita Creek basin, Gila chubs were observed to spawn throughout the year (Griffith and Tiersch 1989). Reproductive activities in Monkey Spring reportedly occurred for longer periods than in other populations, as breeding appeared to last through virtually all seasons (Minckley 1969, 1973, 1985).

Spawning probably occurs over beds of submerged aquatic vegetation or root wads, with large females being followed by several smaller males (Minckley 1973). Griffith and Tiersch (1989) reported ripe males and females with lengths of 90 to 95 mm (3.6-3.8 in). Some Gila chubs, both male and female, reached sexual maturity at the end of their first year in Redfield Canyon.

Typically, most Gila chubs mature in their second or third year of life (Griffith and Tiersch 1989).

Nelson (1993) attempted to identify cover and substrate types, duration of spawning, breeding color changes, and water temperature during spawning in Cienega Creek, Arizona. Intensely colored Gila chubs averaging 163 mm (6.5 in) total length were captured when water temperatures were warmer than 17°C (62°F). Moderately colored fish averaging 93 nun (3.7 in) total length were captured in water temperatures from 13 to 24°C (55 to 75° F). Slightly colored fish averaged 95 mm (3.8 in) total length, and fish displaying no color averaged 73 nun (2.9 in) total length. Intensely, moderately, slightly, and no coloration were present in 23.8 percent, 19.6 percent, 20.3 percent and 36.4 percent of the fish sampled, respectively. Data suggest that individuals greater than 75 to 80 mm (3.0-3.2 in) total length could participate in spawning. Nelson (1993) concluded that warmer water temperatures (20 to 24° C [68 to 75° F]) appear to increase breeding color intensities.

Growth

Gila species typically display sexual dimorphism, with females usually attaining larger sizes than their male counterparts (Minckley 1969, 1973). Female Gila chubs can reach 250 mm (10 in) in total length, but males rarely exceed 150 mm (6 in) (Minckley 1991). This complicates age and growth analysis. The now extinct Monkey Spring population displayed unusual growth patterns with much larger scales, marked size disparity with males being much smaller, and other body shape feature differences.

Griffith and Tiersch (1989) examined scales of Gila chubs from Redfield Canyon, Arizona to determine age class structure. Gila chubs displayed rapidly accelerating growth. Fifty-one percent of yearling scales showed new growth, however, no older fish displayed new growth. During the first year, Gila chubs laid down an average of 14.8 circuli (range of 9-23). Scale analysis indicated that four age groups comprised the population. Back calculation indicated average total lengths were 90 mm (3.6 in), 135 mm (5.4 in), 160 mm (6.4 in) and 183 mm (7.3 in) at the end of the first through fourth years of life, respectively. Total range of fish examined was 45-222 mm (1.8-8.9 in) total length (n=113). Annual growth declined rapidly after the first year.

Foods and Feeding Habits

Griffith and Tiersch (1989) observed that Gila chubs are omnivorous. Adults appeared to be principally carnivorous, feeding on large and small aquatic and terrestrial invertebrates and sometimes other small fishes (Minckley 1991). Smaller individuals often fed on organic debris and aquatic plants (especially filamentous algae), and less intensely on diatoms. Adults usually moved and fed more during the evening and early morning, while young were active throughout the day (Rinne and Minckley 1970; Minckley 1973; Griffith and Tiersch 1989).

No true stomach is present, and there is a one-to-one ratio of gastrointestinal tract length to fish body length (Griffith and Tiersch 1989). Griffith and Tiersch (1989) dissected 27 Gila chub stomachs from Redfield Canyon, finding aquatic material that included speckled dace and dobsonfly nymphs (order Megaloptera). Terrestrial insects included primarily ants, with some caterpillars and beetles. Diatoms were most common by volume. Benthic feeding may also occur as suggested by presence of small gravel particles. Minckley (1969) observed Gila chubs chasing Gila topminnow in Monkey Spring, but not necessarily as prey.

SITE SPECIFIC DISTRIBUTION AND STATUS

As noted earlier, there is some general confusion regarding the taxonomic identification of many populations of chub throughout Arizona. In an attempt to clarify some of this confusion, Table 3 lists taxonomic identifications by museums of specimens collected from streams which Gila chub does not inhabit, or for which some confusion existed regarding their true taxonomic identification.

A section summarizing the status of Gila chub on a stream by stream basis is included for each waterway that currently supports or historically supported Gila chub. Gila chubs are known to have been stocked into three streams in Arizona: Garden Canyon, Larry Creek, and Lousy Canyon. In 1988, AGFD stocked 150 Gila chubs into Garden Canyon, Cochise County, Arizona from Turkey Creek, Santa Cruz County (AGFD files). No Gila chub or any other fishes were captured by AGFD on Fort Huachuca lands in Garden Canyon during sampling conducted in May 1995. Garden Canyon was surveyed because the status of Gila chub stocked in 1988 was unknown. That reintroduced Gila chub population assumedly was extirpated sometime prior to 1995.

Lousy Canyon, Yavapai County, Arizona is tributary to the Agua Fria River. Lousy Canyon was stocked from Silver Creek on July 6, 1995 by AGFD and BLM personnel. Young-of-the-year chub were seined from shallow pools in the vicinity of the road crossing (T1ON R3E, Section 11, SE4). The original intent was to stock approximately 500 individuals into Lousy Canyon and Larry Creek, but due to high mortality during transport, all chub were released into Lousy Canyon. Six hundred fifteen Gila chubs were released into Lousy Canyon (T9N R3E, Section 5, NW4) after all fish transport, handling, and acclimation were completed (Langhorst 1995). Lousy Canyon will require monitoring to document success of the stocking.

Larry Creek, Yavapai County, Arizona is a tributary of the Agua Fria River. It was stocked by BLM personnel on July 20, 1995 from Silver Creek. Gila chub young-of-the-year were seined from the same location as on July 6, 1995 for release into Lousy Canyon. Four hundred twenty three Gila chubs were released into Larry Creek (T9N R3E, Section 9, NW4) (Langhorst 1995). Larry Creek also will require monitoring to document establishment of the population.

Table 3. Summary of miscellaneous SMNH and UMMZ museum collections from Arizona. These collections are either not considered Gila intermedia, or are from populations not included in stream-specific discussions. The species identification reported is taken directly from the identified museum's records. Date is presented as year month day.

Date	Source	Id. as reported by Museum	Collector	Descriptive Location	Other Species
(18)880416	SMNH 39576	GIROIN	Mearns	Verde River, Fort Verde	CAIN
040408	SMNH 130023	GIROIN	Chamberlain	Cienega Spring, 9 mi SW of Safford	
040420	SMNH 130007	GIROIN	Chamberlain	Tonto Creek, Howell's	PACL CAIN AGCH
040422	SMNH 130017	GIROIN	Chamberlain	Fossil Creek, Strawberry, in Yavapai Co.	PACL RHOS
040423	SMNH 130020	GIROIN	Chamberlain	East Verde Creek, Angora, 5 mi N of Payson	PACL RHOS
040425	SMNH 130010	GIROIN	Chamberlain	Tonto Creek at Roosevelt	CAIN AGCH
040425	SMNH 143138	GIROIN	Chamberlain	Salt River, Roosevelt, Maricopa Co.	PACL CAIN CALA AGCH CYCA GIRO PTLU MEFU POOC
260916	UMMZ 94886	intergrade GIROxGIIN	Not available	East Verde River, N Of Payson	PACL RHOS
290419	SMNH 107219	GIROIN	Myers	Gila River, below Gillespie Dam	AGCH POOC
370427	UMMZ 120101	intergrade GIROxGIIN	Jackson	Beaver Creek, above Montezuma Castle, 14N 5E	PACL CAIN
370609	UMMZ 120088	intergrade GIROxGIIN	Tarzwell, Gee	Fossil Creek, @ x-ing below power house	PACL
370617	UMMZ 121660	intergrade GIROxGIIN	Not available	Black River, East Fork- @ Buffalo Crossing	PACL CAIN RHOS
370623	UMMZ 121651	intergrade GIROxGIIN	Not available	Black River, East Fork- @ Three Forks	RHOS
371013	UMMZ 131102	intergrade GIROxGIIN	Tarzwell, Gee	Tonto Creek, below mouth of Christopher Creek	RHOS PACL
430509	UMMZ 146666	intergrade GIROxGIIN	Not available	Gila River, 1 mi below Winkelman	GAAF PACL CAIN POOC AGCH
431031	UMMZ 141721	intergrade GIROxGIIN	Simon	Aravaipa Creek, Aravaipa Canyon	CAIN PACL AGCH MEFU RHOS TICO
500322	UMMZ 162806	intergrade GIROxGIIN	Miller, R.R.	Spring Creek (Tonto Creek trib.) 10 mi W of Young, above Flying W Ranch	PACL RHOS
500521	UMMZ 162803	intergrade GIROxGIIN	Not available	Tonto Creek, above Gisela	PACL CAIN
500527	UMMZ 162823	intergrade GIROxGIIN	Miller, Winn	East Verde River, 2.5 mi above Payson/Pine Highway	PACL RHOS
500527	UMMZ 162820	intergrade GIROxGIIN	Miller, Winn	Fossil Creek, @ bridge x-ing below power house	
790929	AGFD FILES	GIIN	Clarkson	Fossil Creek, @ 3360' elevation	AGCH CAIN LECY PACL

Agua Fria River Basin

Indian Creek

Site Description
Indian Creek, Yavapai County, Arizona is a tributary of the Agua Fria River. It flows in a westerly direction, originating along the western slopes of 22 Mesa, west of the Verde Rim at an elevation of 1420 m (4680 ft). It terminates at the confluence with the Agua Fria at an elevation of 1000 m (3280 ft). Indian Creek is ephemeral from its headwaters to the Prescott National Forest Boundary where it becomes perennial for approximately the next 6.4 km (4 mi). Within the remaining 3.2 km (2 mi) above the Agua Fria River confluence the flow is essentially subsurface.

Land Ownership
Land ownership within a 1.6 km (1.0 mi) buffer around Indian Creek, beginning at its confluence with the Agua Fria River and continuing 24.9 km (15.5 mi) upstream comprises BLM (59 percent), Prescott National Forest (39 percent), and private (2 percent) lands (Indian Creek Land Ownership Map). Private lands are located at the confluence with the Agua Fria River and also a small inholding several miles upstream of the confluence.

Land and Water Uses
Land and water uses on the private lands are unknown. BLM and National Forest lands are primarily used for cattle grazing.

Collection History
Gila chub was not known from Indian Creek until May 1995, when it was collected from a site approximately 1.6 km (1.0 mi) downstream of the Prescott National Forest Boundary (Table C-1). Associated species included longfin dace and desert sucker. Prior to that collection, FFC surveys conducted by BLM biologists at two locations (T11N R3E, Section 26 and 34) over three years reported collecting only longfin dace and desert sucker. These two locations were approximately 1.6 km (1.0 mi) and 3.2 km (2.0 mi) below where chub were found in 1995. BLM and AGFD had proposed introducing Gila chub into Indian Creek prior to the discovery of this population.

Recent Survey Results
Indian Creek was not surveyed for this project due to information available from previous FFC surveys and the survey of May 1995 conducted by Dan Langhorst of the BLM. At that time, Gila chubs (n=18) were found to comprise 29 percent of the fish fauna.

Status, Threats and Management Recommendations
Unstable-Threatened. The lack of historical distribution and abundance data disallows determination of decreases in this population's distribution. However, due to their absence from previous surveys conducted (Fall of 1992, 1993 and 1994) downstream of the May 1995 survey

site, it is reasonable to conclude that their distribution within Indian Creek, at least throughout the early 1990s, has been extremely limited. Annual monitoring of this population for the next several years until a trend can be established is highly recommended, as is a survey to determine their areal distribution. The development of a plan to safeguard the population should also be undertaken.

Silver Creek

Site Description
Silver Creek, Yavapai County, Arizona is a tributary of the Agua Fria River. It flows in a westerly direction, originating along the western boundary of the Pine Mountain Wilderness Area and terminates 19 km (12 mi) downstream at its confluence with the Agua Fria River. Elevations along the creek range from 1650 m (5400 ft) at its headwaters to 945 m (3100 ft) at its confluence with the Agua Fria River.

Land Ownership
Land ownership within a 1.6 km (1.0 mi) buffer along Silver Creek, beginning upstream of the confluence with the Agua Fria River and continuing upstream for 9.3 km (5.8 mi), comprises BLM (75 percent), Tonto National Forest (22 percent) and private (3 percent) lands (Silver Creek Land Ownership Map). None of the private land directly abuts the creek. The creek is perennial throughout most of this reach, but flow is predominantly subsurface within the lower 3.2 km (2 mi).

Land and Water Uses
Land and water uses on private lands are unknown. BLM and National Forest lands are subject to multiple uses including grazing, mining and recreation (including ORV uses).

Collection History
The earliest recorded Gila chub collection in Silver Creek was by **Silvey** in July 1980 (Table C-2). Several subsequent collections were made (Young and Bettaso 1994). The most recent occurred in July 1995. Gila chub is generally common at known sites within Silver Creek, along with green sunfish, longfm dace, desert sucker and fathead minnow. Gila chub has been the only species collected in Silver Creek above a waterfall/barrier located about 4 km (2.5 mi) above the confluence with the Agua Fria River. The successful and abundant recruitment of young-of-the-year Gila chub was a precondition to the translocation of Gila chub from Silver Creek to Larry and Lousy Creeks. Removal of juvenile chub for stockings occurred in July 1995.

Recent Survey Results
Silver Creek was not surveyed for this project due to information available from a number of previous surveys, including those conducted for the translocation efforts of July 1995.

Status, Threats and Management Recommendations

Stable-Threatened. Gila chub is generally a common component of the fish community within Silver Creek. Green sunfish are generally collected within areas also occupied by Gila chub below the waterfall. The presence of a waterfall fish barrier, approximately 4 km (2.5 mi) above the Agua Fria river confluence, undoubtedly has served to forestall any major conflicts between Gila chub and other nonnative fish species above the barrier. Periodic surveys should be initiated to monitor the status of Gila chub and to evaluate the continued effectiveness of the fish barrier.

Sycamore Creek

Site Description

Sycamore Creek, Yavapai County, Arizona is a tributary of the Agua Fria River. It originates at Pine Springs in the Black Hills, within the Pine Mountain Wilderness Area on the western side of the Verde Rim. The creek runs approximately 32 km (20 mi) in a southwesterly direction to the Agua Fria River. Elevations along the stream range from approximately 1790 m (5880 ft) at the headwaters to roughly 1070 m (3520 ft) at its confluence with the Agua Fria River. The stream is perennial throughout most of its length, with the lower 3 km (2 mi) being ephemeral.

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer beginning at the confluence with the Agua Fria River and continuing 29.2 km (18.2 mi) upstream comprises Prescott National Forest (59 percent), BLM (27 percent), private (12 percent) and State Trust (3 percent) lands (Sycamore Creek Land Ownership Map).

Land and Water Uses

Land and water uses on the private lands are primarily those associated with cattle grazing and residences. BLM and State Trust land uses are dominated by cattle grazing. Cattle grazing and recreational activities are the principle uses on Prescott National Forest lands.

Collection History

The earliest collection of Gila chub on record is from a location two miles southeast of Dugas in May 1930 (Table C-3). These fish were originally recorded as *G. robusta,* but later reidentified as *G. intermedia,* (DeMarais 1986). Several other collections from ASU are reported as roundtail chub, but are believed to be Gila chub. Subsequent surveys also recorded Gila chub from Sycamore Creek (most recent in April 1995). FFC surveys conducted in 1990, 1991, 1993 and 1994 by BLM biologists at a site 5 km (3 mi) below Dugas (T11N R3E, Section 11, SW4) failed to collect Gila chub (Table 4).

AGFD, as part of a cost share agreement with Prescott National Forest, conducted surveys of Sycamore Creek within Prescott National Forest in April 1995. Nine sites were surveyed, and three of the nine locations supported Gila chub (Table 5). Distribution of Gila chub within USFS Prescott National Forest lands (Bettaso et al. 1995) was limited to the area of Sycamore Creek

below Double T Waterfall to above Rock Bottom Box, approximately 5 km (3.1 mi). The end points are sites of effective fish barriers, which have served to segregate the fish community. Rainbow trout was the only fish collected above Double T Waterfall during the 1995 survey, while a mix of rainbow trout and Gila chub occupied the area between Double T Waterfall and Rock Bottom Box. Downstream of Rock Bottom Box longfm dace, green sunfish, desert sucker, speckled dace and fathead minnow were collected, with rainbow trout and Gila chub conspicuously absent.

Table 4. Summary of FFC collections in Sycamore Creek, Yavapai County, Arizona at a site 5 km below Dugas, Az. (T11N R3E, Sec. 11, SW4).

11990 (n=74)	1991 (n=584)	1993 (n=679)	1 1994 (n=158)
longfin dace (65%) fathead minnow (24%) green sunfish (9%) desert sucker (1%)	longfin dace (45%) green sunfish (32%) fathead minnow (21%) desert sucker (2%)	longfm dace (61%) desert sucker (33%) fathead minnow (3%) speckled dace (2%) green sunfish (1%)	longfm dace (44%) desert sucker (30%) green sunfish (15%) speckled dace (8%) fathead minnow (3%)

Table 5. Summary of fish collections from Sycamore Creek, Prescott National Forest, Yavapai County, Arizona in April 1995 (Bettaso et al. 1995). Species code abbreviations are defined in Appendix A.

Location	Species collected (relative abundance) (total n collected)
below Nelson Place spring (T11N R5E Sec. 21 NE4 NE4)	ONMY (100%) (n=42)
below wildlife exclosure (T11N R5E Sec. 20 NE4)	ONMY (100%) (n=52)
below Double T Ranch above Falls (T11N R5E Sec. 19 NE4 NE4)	ONMY (100%) (n=51)
0.75 mi below Double T Ranch (T11N R5E Sec. 19 NW4 SW4)	GIIN (72%), ONMY (28%) (n=85)
confluence with South Prong (T11N R4E Sec. 24 SE4)	ONMY (64%), GIIN (36%) (n=11)
Middle Box Barrier (T11N R4E Sec. 23 NE4 SE4)	GUN (75%), ONMY (25%) (n=20)
Rock Bottom Box, above barrier (T11N R4E Sec. 14 SE4 SW4)	No fish collected
above Dry Creek confluence (T11N R4E Sec. 9 NE4 SW4)	PACL (39%), RHOS (34%), AGCH (27%) (n=204)
FS Admin. Site (T11N R4E Sec. 7 NE4 NE4)	PACL (53%), AGCH (30%), RHOS (11%), LECY (3%), PIPR (3%) (n=177)

Recent Survey Results

Sycamore Creek was not surveyed for this project due to information available from a number of previous surveys, including that conducted by AGFD in April 1995 (Bettaso et al. 1995).

Status, Threats and Management Recommendations

Stable-Threatened. The presence of the barrier at Rock Bottom Box undoubtedly has served to forestall any upstream movement of nonnative fish, while Double T Falls has effectively blocked Gila chub from invading the upper most sections of Sycamore Creek. The rainbow trout found in the upper sections are purportedly the descendants of 2,000 juvenile rainbow trout stocked into upper Sycamore Creek on April 10, 1942 (Bettaso et al. 1995). With the integrity of the Rock Bottom Box barrier maintained, it is unlikely that additional nonnative fish will become a management concern, at least within the upper sections of the creek, unless nonnnatives are moved by people. Overuse of riparian galleries and the upland watershed by livestock, along with impacts by recreational users along the lower stretches of the creek, does represent a potential threat to the long term health of this stream.

Information from historical collections is inadequate to determine past distribution or declines in distribution or abundance. Collection of Gila chub in 1979 at the USFS Administration site and subsequent failure to collect them during FFC surveys in 1990-1994 indicate the lower portion of Sycamore Creek may not be occupied. Gila chub is currently known to occupy only about 5 km (3 mi) of the 29.2 km (18.2 mi) of Sycamore Creek delineated on the Sycamore Creek Land Ownership map (all of which may not be perennial).

Little Sycamore Creek

Site Description

Little Sycamore Creek, Yavapai County, Arizona is a tributary of Sycamore Creek, originating at the confluence of several unnamed streams flowing from Chalk Tank Canyon, Rock Spring Draw, and Willow Spring at an elevation of 1290 m (4240 ft). Little Sycamore Creek flows in a westerly direction approximately 5 km (3 mi) to its confluence with Sycamore Creek, near Dugas, at an elevation of 1210 m (3960 ft). The stream is ephemeral throughout most of its length, with only a short perennial section at the spring above Horner Mountain Ranch. Below Horner Mountain Ranch, the flow becomes subsurface, leaving only a few isolated pools present within the stream channel.

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along Little Sycamore Creek from its confluence with Sycamore Creek upstream 5.3 km (3.3 mi) comprises Prescott National Forest (78 percent), private (20 percent), and BLM (2 percent) lands (Little Sycamore Creek Land Ownership Map).

Land and Water Uses

Land and water uses on private lands are primarily those associated with cattle grazing and private residences. On BLM and Prescott National Forest Lands cattle grazing and recreational activities are the principle uses. There are several USFS and private roads paralleling the stream and crossing it. The majority of private lands are located along the stream course.

Collection History
The earliest recorded collection of Gila chub was in August 1980 near Dugas (Table C-4). Subsequent collections of Gila chub were made in April 1995 from sites near the confluence with Reno Canyon and from just below the spring above Homer Mountain Ranch (Bettaso et al. 1995). Species collected in association with Gila chub (7 percent, n=5) were longfin dace (73 percent) and desert sucker (20 percent).

Recent Survey Results
Little Sycamore Creek was not surveyed for this project due to information available from AGFD as part of a cost share agreement with the Prescott National Forest (Bettaso et al. 1995).

Status, Threats and Management Recommendations
Unstable-Threatened. Information on the historic abundance or distribution of Gila chub is inadequate to determine possible trends in this population. Gila chubs were found in low numbers (actual and relative abundance) at the two sites that were sampled during the April 1995 survey. A lack of available habitat due to the ephemeral nature of the creek is most likely the primary cause. Availability of habitat and the distribution of Gila chub within that habitat should be investigated.

Salt River Basin

Cave Creek and Seven Springs Wash

Site Description
Cave Creek is an intermittent stream about 48 km (30 mi) north of Phoenix in Maricopa County, Arizona. Seven Springs Wash, a spring-fed perennial stream is a tributary of Cave Creek. Cave Creek runs from an elevation of 1340 m (4400 ft) near its headwaters to 550 m (1800 ft) near Cave Creek Dam. Cave Creek historically connected with the Salt River in Phoenix only during floods, but currently flood flows are interrupted by Cave Creek Dam.

Land Ownership
A Land Ownership Map was not produced for this stream as Gila chub is extirpated from it (Rinne 1975). Approximately 2.4 km (1.5 mi) of Cave Creek are privately owned, with the remainder of perennial reach managed by the USFS Tonto National Forest.

Land and Water Uses
The Cartwright Ranch maintains a collection box and irrigation canal in Seven Springs Wash to convey water for a pond and pastures. The remainder of spring flow continues through the Cave Creek/Seven Springs Campground and down Cave Creek. USFS lands along Cave Creek are subject to multiple uses as mandated by Congress and may be grazed, mined or provide for recreational opportunities. Cattle, cattle sign, hiking, and other signs of recreation were frequently observed in 1992 (Young and Bettaso 1994). A USFS campground is present at the confluence of Seven Springs Wash and Cave Creek, and a hiking trail follows Cave Creek

downstream from this point. Roads in the area have resulted in several concrete stream crossings that likely serve as barriers to upstream movement of fish under most flow regimes, but the potential for transport by people is high.

Collection History

Gila chubs were first collected by Miller and Winn in 1950 (Table C-5). They were subsequently collected through 1978. Stout et al. (1970) found Gila chubs comprised 12 percent of all fish collected in Seven Springs, but did not find them at eight other sample locations downstream in Cave Creek. Several age classes were present and the population was considered reproductively active as determined by presence of small specimens. Rinne (1975) reported Gila chubs predominantly restricted to the headspring pool of Seven Springs in 1970 and exclusively restricted to the headspring pool in 1971. Stout et al. (1970) found them throughout Seven Springs Wash. Seven Springs was renovated in 1970 and 1971 in attempts to establish populations of spikedace and loach minnow (Rinne 1975). Rinne (1975) reported collecting five specimens of Gila chub in the Seven Springs Wash headspring in summer 1971, but failed to collect any in May 1973. Stefferud (1992) reported that Gila chub have not been collected in the Cave Creek drainage since 1971. However, Clarkson collected Gila chubs from Cave Creek near the campground in 1978 (ASU collection #7764). Clarkson also surveyed Seven Springs in 1979 and reported collecting only longfm dace (Bancroft et al. 1980).

Annual monitoring of Cave Creek and/or Seven Springs by AGFD biologists as part of the Gila topminnow reintroduction program occurred in 1985 to 1987, 1989, and 1991 to 1995 (AGFD NFDB). No chub were collected during these efforts, however most surveys were conducted using dipnets and seines, which may have been less effective at capturing Gila chubs.

As a result of a Biological Opinion issued by the USFWS on the Quien Sabe prescribed burn, the USFS Tonto National Forest was required to conduct monitoring in Cave Creek and Seven Springs. Monthly monitoring conducted April through December 1992 (except September) at three sites resulted in the capture of 4,709 longfm dace, 1,122 fathead minnows, and 2,187 Gila topminnow (Stefferud 1992). No Gila chubs were collected.

In September 1992 AGFD conducted surveys at five sites on Cave Creek between the Seven Springs confluence and the southern boundary of the Tonto National Forest, and one site in Matty's Fork, a tributary of Cave Creek under a Challenge Cost Share agreement with Tonto National Forest. No Gila chubs were collected during these surveys (Young and Bettaso 1994).

Species collected and/or stocked in Cave Creek and Seven Springs to date include: Gila chub, Gila topminnow, spikedace, loach minnow, longfm dace, speckled dace, fathead minnow, green sunfish, mosquitofish, and channel catfish (Silvey et al. 1984). Recent collection data (AGFD NFDB) indicate that longfin dace, green sunfish, and fathead minnow are the only species currently present in Cave Creek.

Recent Survey Results
Cave Creek and Seven Springs were not surveyed due to the amount of information available from previous work.

Status, Threats and Management Recommendations
Extirpated. Seven Springs Wash and Cave Creek formerly provided habitat for Gila chub. They were found as far downstream as four miles north of Cave Creek, Arizona, in 1950. Early collections reported only Gila chub and speckled dace, but longfm dace were present after 1969. Based on available information, Gila chubs are considered extirpated from Cave Creek and Seven Springs.

Fish Creek

Site Description
Fish Creek, Maricopa County, Arizona, is a tributary of the Salt River. It flows in a northwesterly direction from its headwaters in the Superstition Mountains within the Superstition Wilderness Area, to its confluence with the Salt River approximately 2.4 km (1.5 mi) below Horse Mesa Dam. Elevations along the stream range from 1460 m (4800 ft) at its headwaters to 500 m (1660 ft) at its confluence with the Salt River. It is an intermittent stream, with areas composed of deep, isolated pools persisting year round.

Land Ownership
Fish Creek is approximately 25 km (16 mi) in length and is within Tonto National Forest; 15.3 km (9.5 mi) upstream of the Arizona Highway 88 bridge, is within the Superstition Wilderness Area. A land ownership map was not produced for this stream.

Land and Water Uses
Land and water uses in the vicinity of Fish Creek are primarily associated with recreation (i.e. camping, hiking and fishing), although grazing is likely occurring within the watershed.

Collection History
The earliest reported collection of Gila chub (reported as *G. robusta)* was in October of 1963 by W.L. Minckley (Table C-6). A second collection (again recorded as *G. robusta)* was made in October of 1965 by W.L. Minckley. Both collection localities were reported simply as Fish Creek NE of Tortilla Flat. Those specimens were later identified as *G. intermedia* (Rinne 1969; DeMarais 1986). No subsequent collections of Gila chub have been made. A survey conducted by AGFD for this project in June 1993, from the Arizona Highway 88 bridge upstream to the confluence with Little Goat Canyon, found only longfin dace.

Status, Threats and Management Recommendations
Extirpated. Gila chub is considered extirpated from Fish Creek. Information on the distribution and abundance of Gila chub in Fish Creek is inadequate to determine the amount of Gila chub range lost. Evaluation of this stream for potential restocking is recommended.

Rye Creek

Site Description
Rye Creek is a first order tributary to Tonto Creek, Gila County, Arizona. Its headwaters are in the Mazatzal Mountains of central Arizona near an elevation of 1220 m (4000 ft). It joins Tonto Creek south of Gisela near 820 m (2700 ft).

Land Ownership
Land ownership within a one mile (1.6 km) buffer beginning at the confluence with Tonto Creek and continuing upstream 15.5 km (9.6 mi) comprises Tonto National Forest (93 percent) and private (7 percent) lands. Although a majority of the land is Federally owned, private lands are found mostly along the stream course.

Land and Water Uses
Tonto National Forest Lands are open to cattle grazing, recreation and other uses as allowed in the Land Management plan as developed under the National Forest Management Act. During surveys in 1995, no water diversions, pumping or wells were observed within Rye Creek. Several small ranches are along the creek. Cattle grazing was observed near the confluence with Tonto Creek and also above the Highway 87 bridge, an area that is not perennial. According to the Land Ownership Map, there are numerous mines within the watershed, but it is not known whether or not they are active.

Collection History
Stream habitat surveys were conducted by AGFD in 1979 (Bancroft et al. 1980). One stream reach of unreported length was electrofished and the following fish (n=458) were collected: desert sucker (36 percent), longfm dace (26 percent), Sonora sucker (23 percent), speckled dace (4 percent), fathead minnow (4 percent), red shiner (4 percent), yellow bullhead (2 percent) and *Gila (<1* percent). Two *Gila* were preserved and stored in the ASU Museum of Fishes (Table C-7). DeMarais (1986) indicates that these specimens are phenotypically intermediate "grahami" specimens.

Rye Creek also was sampled one mile above the confluence with Tonto Creek in 1991 (Abarca and Weedman 1993). One run, pool, and riffle were seined and desert sucker (66 percent), longfin dace (29 percent), carp (2 percent), fathead minnow (1 percent), channel catfish (1 percent) and speckled dace (<1 percent) were collected (total n=494).

Recent Survey Results
Rye Creek was sampled for this project in October 1995 to determine the abundance and distribution of *Gila,* and to obtain further specimens for identification. Approximately 1.2 km (0.75 mi) beginning just above Forest Road 184 bridge and continuing downstream to private property nearing Tonto Creek was electroshocked. Five native species (longfm dace [33 percent], desert sucker [28 percent], Sonora sucker [23 percent], speckled dace [6 percent] and one *Gila [*<1 percent]) and three nonnative species (smallmouth bass [7 percent], yellow

bullhead [2 percent] and red shiner [<1 percent]) were collected (total n=681). Extra shocking effort was expended in pool and deeper run habitats reportedly preferred by chubs in order to capture more of them, but no more were encountered. Also, for that reason, smallmouth bass may be over-represented in the sample. Several areas upstream from that previously mentioned were visited in 1995, but no other surface water was encountered.

The one *Gila* collected was preserved (ASU Collection #14281). The following counts were made: dorsal rays =9, anal rays=8, lateral line scales =87, and ratio of head length/peduncle depth=3.1. Based on these parameters, this specimen exhibits characteristics intermediate between *G. intermedia* and *G. robusta.* The specimen will be deposited in the ASU Museum of Fishes. Positive identification of individual specimens remains problematic, and keys developed by Rinne (1969) and DeMarais (1986) are based on the mean conditions within a population. Individual specimen identification may not be possible (Minckley 1973), however DeMarais (1995) indicated that use of one or two characters, e.g. dorsal fm-ray counts and/or caudal peduncle depth, is adequate for identification of *G. intermedia* relative to *G. robusta.* This specimen is tentatively identified as a phenotypically intermediate roundtail chub, but more specimens are needed to verify identity of the population.

Status, Threats and Management Recommendations
The specific identity of chub encountered in Rye Creek is still undetermined. DeMarais (1995) indicated that chub in Rye Creek were intermediate between *G. robusta* and *G. intermedia,* closely resembling those in Tonto Creek. However, Rye Creek chub more closely approached the *G. intermedia* phenotype, in particular exhibiting only eight dorsal fin rays (a defining character of *G. intermedia).* Sample sizes are too small to statistically validate this observation. We consider this population to be *G. robusta, similar* to Tonto Creek *Gila,* although more closely approaching the Gila chub phenotype.

The first recorded presence of smallmouth bass in Rye Creek was in 1995. They were previously encountered in Tonto Creek, and may have invaded naturally or by human assistance. In combination with the limited habitat available in Rye Creek, smallmouth bass pose a serious threat to chub in Rye Creek, regardless of its taxonomic identity.

Verde River Basin

Woods Canyon and Mullican Canyon are tributaries to Beaver Creek and Red Tank Draw, respectively. They were surveyed in 1995 for this project. No Gila chub were collected from either site. Sites on Dry Beaver Creek were also surveyed for this project in 1995, but no Gila chub were collected.

Walker Creek

Site Description
Walker Creek is a tributary of Wet Beaver Creek in Yavapai County, Arizona. It runs north and west from an elevation of 1710 m (5600 ft) on Walker Mountain down to 1200 m (3600 ft) at

the confluence with Wet Beaver Creek. The lower 1.6 to 3.2 km (1 to 2 mi) is ephemeral. The mid-reach of the stream flows through a steep narrow canyon.

Land Ownership

Land ownership within a 1.6 km (1 mi) buffer along Walker Creek beginning near its confluence with Wet Beaver Creek and continuing upstream for 11.3 km (7.0 mi) comprises Coconino National Forest (93 percent), ASLD (6 percent) and National Park Service, Montezuma Well National Monument (1 percent) lands (Walker Creek Land Ownership Map).

Land and Water Uses

The lower and upper 1.6 to 3.2 km (1 to 2 mi) of stream are open to grazing on USFS lands. The middle reach of stream is confmed in a steep canyon, which is inaccessible to cattle. Water uses at the privately owned ranch at the mouth of the narrow canyon are unknown. Forest Road 618 crosses Walker Creek about 1.6 km (1.0 mi) upstream from Wet Beaver Creek. Dispersed recreation (hiking and backpacking) and cattle grazing are predominant land uses within the watershed.

Collection History

Walker Creek was surveyed as part of this project by AGFD, Region II in 1994 at five locations throughout the stream (Table 6). Three of the five locations supported Gila chub. Specimens were preserved, but have not been positively identified. They are believed to be Gila chub based on DeMarais (1986) identification of previously collected specimens (Table C-8). Sites containing Gila chub encompass about 7.2 km (4.5 mi) of stream. Length of perennial reach (i.e. available habitat) is not known.

Table 6. Summary of fish collected from Walker Creek, Yavapai County, Arizona in June-July 1994.

Location	Species collected (percent relative abundance) (total n collected)
T15N R6E Sec. 32 SE4 NE4	None (dry)
T15N R6E Sec. 33 center	None (dry)
T15N R6E Sec. 34 SE4 SW4	speckled dace (92%), Gila chub (6%), desert sucker (2%), n=379
T15N R6E Sec. 35 NE4 SE4	speckled dace (79%), Gila chub (15%), desert sucker (6%), n=238
T14N R6E Sec. 1 SE4 SE4	speckled dace (79%), Gila chub (16%), desert sucker (5%) n=63

Recent Survey Results

Based on information available from 1994, this stream was not surveyed for this project. However, a tributary of Walker Creek, Spring Creek, was surveyed for 1.5 miles above the confluence with Walker Creek. The entire stream was dry.

Status, Threats and Management Recommendations

Stable-Threatened. Lack of historical distribution and abundance information prohibits determining trends in abundance or changes in distribution of Gila chub. The ephemeral nature of the lower end of Walker Creek appears to be limiting invasion of nonnatives from Wet Beaver Creek. This population should remain relatively secure unless perturbations drastically alter the habitat. Monitoring of this population over time may indicate it is a Stable-Secure population.

Red Tank Draw

Site Description

Red Tank Draw is a tributary of Wet Beaver Creek in Yavapai County, Arizona. It flows south and west and joins Wet Beaver Creek very near the confluence of Wet Beaver Creek with Walker Creek, a stream known to contain Gila chub. Red Tank Draw is an intermittent stream approximately 16 km (10 mi) in length.

Land Ownership

Lands within the Red Tank Draw watershed are owned and managed by USFS, Coconino National Forest. Private lands are also identified on the USFS Coconino National Forest map near the confluence with Wet Beaver Creek. No land ownership map was produced for this stream.

Land and Water Uses

Land and water uses within Red Tank Draw are those associated with the multiple use mandate of the USFS. There are not any known diversions or withdrawls of water from Red Tank Draw. The U.S. Geological Survey maintains a gaging station in the mid-reach of the stream.

Collection History

On October 14, 1995 Red Tank Draw was sampled by Department biologists and volunteers for this project. Green sunfish and Gila chubs were collected from pools above and below the crossing of Forest Road 618. Two chub specimens were preserved. It was sampled again in December, 1995, in an attempt to capture more large specimens of Gila chub for identification. Thirty two chubs were captured, two were preserved and thirty released. The released chub were considered too small to get accurate meristic counts. Several hundred small to medium sized green sunfish were also collected incidental to those efforts. The results of selected meristic counts and morphometric measurements from those specimens is presented in Table 7. All specimens will be submitted to the ASU Collection of Fishes for verification.

The results of these counts and measurements indicate that the specimens are Gila chubs. The discovery of this population delivers hope that there are more undiscovered populations of Gila chub present.

Table 7. Selected counts and measurements of Gila chub specimens collected from Red Tank Draw, Yavapai County, Arizona.

Date	TL (mm)	dorsal rays	anal rays	head length (mm)	peduncle depth (mm)	Ratio (hl/pd)
951014	152	8	8	33.4	12.2	2.7
951014	131	8	8	28.0	9.9	2.8
951220	119	8	8	25.5	9.5	2.7
951220	102	8	8	23.5	9.0	2.6

Status, Threats and Management Recommendations

Unknown. Red Tank Draw should be the focus of more intensive surveys to determine range of distrubution and abundance. Additional specimens should be collected and subjected to detailed morphometric and genetic analysis to verify the identity of these chub.

Oak Creek

Site Description

Oak Creek is a tributary of the Verde River in Yavapai and Coconino counties, Arizona. It flows south from the Mogollon Rim near Flagstaff at an elevation of about 2190 m (7200 ft) to its confluence with the Verde River at 970 m (3,170 ft). Three AGFD hatcheries operate within the Oak Creek drainage: Page Springs, Bubbling Ponds and Sterling Springs hatcheries.

Land Ownership

Land ownership within a one mile buffer of Oak Creek from the Verde River confluence upstream 80.6 km (50.1 mi) to Sterling Springs Hatchery comprises Coconino National Forest (69 percent), private (27 percent), State (2 percent), Coconino County (1 percent), AGFD (<1 percent) and Prescott National Forest (<1 percent). Private lands are included in several municipalities (Sedona, Cornville and Oak Creek) along Oak Creek. AGFD lands are at the Page Springs, Bubbling Ponds and Sterling Springs fish hatcheries.

Land and Water Uses

National Forest lands are used for cattle grazing, fuelwood cutting, logging and recreation. The Red Rock/Secret Mountain Wilderness Area encompasses a significant amount of the western half of the Oak Creek watershed. Water use along Oak Creek includes withdrawal of unknown amounts for municipal, agricultural and industrial purposes.

Collection History

Oak Creek has been an intensively managed stream since early settlement by man. Native species known to inhabit Oak Creek prior to interference by man were longfm dace, speckled dace, roundtail chub, desert sucker, Sonora sucker and native trout. Occurrences of spikedace, razorback sucker, Colorado squawfish and loach minnow were also possible near the confluence

with the Verde River. Silvey et al. (1984) reported the following nonnative species present or stocked into Oak Creek: largemouth bass, smallmouth bass, rock bass, black bullhead, yellow bullhead, channel catfish, mosquitofish, red shiner, green sunfish, brown trout, cutthroat trout and rainbow trout. Carp is also known from Oak Creek (Minckley 1973). The AGFD NFDB also reports collections of warmouth, fathead minnow, and flathead catfish from oak Creek. Walleye have also been released from Page Springs hatchery into Oak Creek (Roger Sorenson, AGFD, pers. comm.).

Gila specimens collected in 1936 by Gee were originally identified as *G. robusta* that were approaching *G. intermedia* (Table C-9). Rinne (1969, 1976) reported that a small sample of juvenile fish from upper Oak Creek had counts and features suggestive of Gila chub. Minckley (1973) reported a suspected introduction of Gila chub into Oak Creek. However, more recent collections of Gila chub included in this report from Oak Creek tributaries suggest that they may be native.

Although there have been no recent collections of Gila chub from the mainstream of Oak Creek, Gila chub presently occur in Spring Creek, a small, low-gradient tributary near the town of Page Springs (AGFD NFDB). Gila chubs are abundant in Spring Creek, but they have never been found immediately downstream at the confluence with Oak Creek, even though no physical barrier exists which would preclude their movement. Gila chus must, on rare occasions, reach Oak Creek from Spring Creek or perhaps other tributary populations. Therefore, collection of Gila chub in Oak Creek would not be entirely unexpected.

Recent Survey Results
Oak Creek was not surveyed for this project.

Status, Threats and Management Recommendations
Oak Creek was not given a status ranking. Whether *G. intermedia* at one time maintained a self-reproducing population in Oak Creek is unknown, but it seems unlikely for a variety of reasons. First, *G. robusta* occurs (or occurred) in Oak Creek (Minckley 1973). Second, most reaches of the relatively large and steeply grading Oak Creek are more characteristic of *G. robusta* habitat than that of *G. intermedia*. Lower gradient, marshy stretches, if present, could provide habitat for Gila chub. We do not feel that Oak Creek contains a viable reproducing population of Gila chub, although they may occasionally be found in Oak Creek as a result of active or passive dispersal from Spring Creek.

Spring Creek

Site Description
Spring Creek is a tributary of Oak Creek in Yavapai County, Arizona. It flows south near Casner Mountain at an elevation of 1830 m (6000 ft) approximately 26 km (16 mi) to its confluence with Oak Creek at 1020 m (3340 ft) in elevation. The entire upper 23 km (14 mi) are ephemeral and surface flow begins approximately two miles above the confluence.

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along Spring Creek beginning at the Oak Creek confluence and continuing upstream 21.1 km (13.1 mi) comprises Coconino National Forest (73 percent), State (14 percent), private (12 percent) and AGFD (<1 percent) lands (Spring Creek Land Ownership Map). A large majority of the land along the known perennial reach of Spring Creek is private.

Land and Water Uses

Spring Creek is dry throughout its upper reach and becomes perennial shortly upstream from the crossing of Forest Road 796 at a spring in T16N R4E, Section 22, NM. The upper watershed is grazed on USFS and ASLD lands. Land uses on private lands are unknown. There are no known diversions from Spring Creek and all surface flow contributes to the discharge of Oak Creek.

Collection History

Gila chubs were first collected from Spring Creek by Clarkson (Bancroft et al. 1980) in 1979 (Table C-10) at an elevation of 1085 m (3560 ft), which is about 300 m (980 ft) downstream from the spring source. All subsequent collections presumably were made upstream and downstream from Forest Road 796 crossing. Gila chubs were collected near the road crossing by DeMarais in 1983 and 1985. They were also collected by AGFD Region II fish biologists in 1994 (Table 8).

Recent Survey Results

In September 1995, AGFD biologists surveyed Spring Creek to determine the abundance and distribution of Gila chub. The only access to areas of perennial water on public lands was at Forest Road 796 crossing, where Gila chubs were again collected (Table 8.). Twelve Gila chubs were preserved and will be sent to ASU. The collection of fathead minnow in 1995 was the first reported for this stream. They could have came from upstream migration from Oak Creek or release by fisherman.

Failure to collect smallmouth bass in 1995 (collected in 1979) is likely the result of the limited area available for surveys. They are likely still present in Spring Creek. Five other locations upstream of the spring source on public or ASLD lands were visited, which were dry in 1995.

Table 8. Summary of fish collected from Spring Creek, Yavapai County, Az. near the Forest Road 796 crossing in 1994 and 1995.

1994 (n=205)	**PACL (40%), RHOS (34%), GIIN (18%), CAIN (8%)**
1995 (n=312)	**RHOS (46%), PACL (26%), GIIN (12%), AGCH (7%), PIPR (<1%)**

Status, Threats and Management Recommendations

Stable-Threatened. Gila chub was moderately abundant in 1995, and has been present since at least 1979. In 1994, total lengths ranged from 52 mm to 250 mm (2 to 10 in). Mean length was

84.8 mm (3.34 in, n=36). In 1995, total lengths of Gila chub ranged from 36 mm to 114 mm (1 to 5 in). Mean length was 69.6 mm (2.7 in, n=38). These data indicate all age classes of Gila chub were present and the population was actively reproducing.

Available habitat for Gila chub is limited in Spring Creek, and nonnatives in Oak Creek may pose a threat. Most land along the perennial reach of Spring Creek is privately owned, and possible impacts from development or land uses are unknown.

Williamson Valley Wash and Big Chino Wash

Site Description
Williamson Valley Wash, Yavapai County, Arizona, is a tributary of Big Chino Wash, which is in turn a tributary of the Verde River above Sullivan Lake, near Paulden, Arizona. Big Chino Wash begins near Seligman and flows southeasterly through Chino Valley. Williamson Valley Wash flows north and then east where it joins Big Chino Wash. Both of the streams are intermittent.

Land Ownership
Land ownership within a 1.6 km (1.0 mi) buffer along Williamson Valley Wash beginning at the Williamson Valley Road bridge and continuing downstream about 9.7 km (6 mi) to T17N R3W, Section 8, NE4 comprises private (95 percent) and ASLD (5 percent) (Williamson Valley Wash Land Ownership map). The entire stream reach is abutted by private lands, with State land located away from the stream channel.

Land and Water Uses
Land uses occurring within Williamson Valley include agriculture, grazing, and possibly timber and fuelwood cutting. Other uses are unknown.

Collection History
Gila chub and Sonora sucker were collected in 1950 from Big Chino Wash (Table C-11). No subsequent collections are available from Big Chino Wash. Gila chubs were also collected from an isolated pool in Williamson Valley Wash in 1992 by Bettaso and Anderson in conjunction with the Gila Taxonomy Project (Rob Bettaso, AGFD, pers. comm.). Twenty chub were collected, frozen and taken to the University of Texas in Austin. Other reported fishes were mosquitofish and an undetermined sucker species. During flooding in early 1993, that isolated pool was completely filled in with sand and gravel and Gila chub may be extirpated (Tom Liles, AGFD, pers. comm.)

Recent Survey Results
Big Chino Wash and Williamson Valley Wash were not surveyed for this project.

Status, Threats and Management Recommendations
Extirpated (tentative). Big Chino and Williamson Valley Washes are ephemeral (Sue Schuhardt, USFS, pers. comm.). Gila chub may still exist in tributaries to these drainages, however intensive surveys of tributary streams may be necessary to locate them.

Queen Creek and Arnette Creek

Site Description
Queen Creek, Pinal County, Arizona is an ephemeral stream originating near the town of Superior at an elevation of 1220 m (4000 ft). Arnette Creek is a tributary of Queen Creek, a tributary of the Gila River. Arnette Creek is intermittent, with a short perennial reach north of Picketpost Mountain, also near Superior.

Collection History
Gila chub was reportedly stocked from the Salt River near Tempe, Arizona into a pond at the Boyce Thompson Arboretum during the 1930s by C.L. Hubbs (Minckley and Brooks 1985). Gila chubs were collected from Arnette Creek in 1945 and from Queen Creek, near Boyce Thompson Arboretum in 1938 (Table C-12). Gila topminnow, desert pupfish and fathead minnow currently occupy the Arboretum pond. No chub have been collected in Queen Creek since 1938. Arnette Creek was sampled several times during Gila topminnow reintroduction evaluations, but no chub were collected.

Status, Threats and Management Recommendations
Extirpated. Historical distribution and abundance data for Gila chub in Queen and Arnette creeks is insufficient to determine the net effect the loss of this population has on range-wide distribution. The presence of Gila chub in these two streams may be the result of an introduction in the 1930s and therefore, not natural historical Gila chub range. Perennial water is non-existent in Queen Creek and available in only about a 3 km (2 mi) reach of Arnette Creek. Gila chub is considered extirpated from these streams. Tonto National Forest recently proposed renovation of Arnette Creek to remove mosquitofish and green sunfish, and reintroduction of longfin dace, desert sucker, Sonora sucker and Gila chub to follow the successful renovation. An implementation schedule is not yet available.

San Carlos River

Site Description
The San Carlos River, Gila and Graham counties, Arizona is a tributary of the Gila River. The rivers are impounded by Coolidge Dam to form San Carlos Reservoir southeast of Globe. The San Carlos River flows from an elevation of 1550 m (5100 ft) in the Natanes Mountains to an elevation of 760 m (2500 ft) at San Carlos Reservoir.

Land Ownership
A total of 17,643 hectares (43,596 acres) within a 1.6 km (1.0 mi) buffer zone along 80.4 km (50.0 mi) of the San Carlos River beginning just above San Carlos Reservoir and continuing upstream is owned and managed by the San Carlos Apache Tribe.

Land and Water Uses
The San Carlos River watershed is used for grazing by several cattle associations (Cliff Schlusner, FWS, pers. comm.). The San Carlos Nation is considering allowing prospecting for lithium deposits within the Blue and San Carlos watersheds. Other land and water uses are unknown.

Collection History
The earliest known collection of Gila chub from the San Carlos River was in 1968 by W. L. Minckley (Table C-13). The only other known collection was by DeMarais in 1983 at an undisclosed location.

Recent Survey Results
Due to access restrictions, the San Carlos River was not surveyed.

Status, Threats and Management Recommendations
Unknown. Gila chubs are known to be present in the San Carlos River (Stewart Jacks, FWS, pers. comm.), but relative abundances and other fish species are unknown. Current land management practices (heavy grazing) are believed to be damaging the watershed, but are not documented. Lack of historical and current information on population status of Gila chub precludes summarizing the status of this population.

Blue River

Site Description
The Blue River is a tributary of the San Carlos River entirely on the San Carlos Apache Indian Reservation, Gila County, Arizona. It flows from an elevation of 1300 m (4280 ft) at Blue River Spring to 850 m (2780 ft) at the San Carlos River confluence.

Land Ownership
A total of 6,705 hectares (16,567 acres) within a 1.6 km (1.0 mi) buffer zone along 20.0 km (12.5 mi) of the Blue River, from its confluence with the San Carlos River upstream to Blue River Spring, is owned and managed by the San Carlos Apache Indian Reservation.

Land and Water Uses
The Blue River watershed is heavily grazed by several cattle associations, and abandoned asbestos mines are present (Cliff Schlusner, FWS, pers. comm.). The San Carlos Nation is considering allowing prospecting for lithium deposits within the Blue and San Carlos river watersheds.

Collection History
Gila chubs were first collected by Miller and Winn in 1950 in association with desert sucker. The collection locality given was simply 30 miles northeast of Globe. Gila chubs have been collected several times since 1950 (Table C-14). The most recent collections were in 1993 at several undisclosed locations, where Gila chubs were considered common at all sites sampled (Stewart Jacks, FWS, pers. comm.). Gila chubs were also collected in 1995 where the 1200 Road crosses the Blue River (Cliff Schlusner, FWS, pers. comm.). Pending availability of USFWS survey data from 1993 and 1995, quantitative information on this strteam is not available.

Recent Survey Results
Due to access restrictions, the Blue River was not sampled.

Status, Threats and Management Recommendations
Unknown. Gila chubs are known to be present in the Blue River, along with desert sucker, but other species presence and relative abundances are unknown. Cliff Schlusner (FWS, pers. comm.) reported observing an unusually high incidence of spinal deformity in chubs collected there in 1995. The cause of the deformity is unknown, but waste from the abandoned asbestos mines is the suspected cause. The USFWS Pinetop FAO is investigating the situation (Cliff Schlusner, FWS, pers. comm.).

Historical distribution and qualitative information on Gila chub is not available, therefore possible declines in distribution and/or abundance are indeterminable. If the development of mines continues, this population could become threatened.

Santa Cruz River

Site Description
The Santa Cruz River flows about ten miles from its headwaters in the San Rafael Valley, Santa Cruz County to the Arizona-Mexico border, passes through Mexico and then returns to Arizona. It then passes about 120 miles from the border through Santa Cruz, Pima, and Pinal counties to the Santa Cruz Flats near Eloy. Length of the Santa Cruz River in Mexico is unknown. The river begins at an elevation of 1585 m (5200 ft) in the Canelo Hills of Arizona and ends at an elevation of 460 m (1500 ft) in the Santa Cruz Flats. It loops around and drains all sides of the Patagonia and Santa Rita mountains. The Santa Cruz River and its tributaries also drain the northern Canelo Hills, western Rincon Mountains and southern Santa Catalina Mountains. There is no evidence that the Santa Cruz River historically extended as surface flow to the Gila River. Hendrickson and Minckley (1984) provide a more complete description of present and historical habitat conditions within the Santa Cruz basin.

Land Ownership
A Land Ownership Map was not produced for the Santa Cruz River, but it is known to flow through private, State and Federal lands, as well as the cities of Nogales, Green Valley and

Tucson. Many of the tributaries drain Coronado National Forest land. Bog Hole Wildlife Area (BHWA), a man made impoundment containing nonnative fishes, is located at the headwaters in the San Rafael Valley.

Land and Water Uses
The Santa Cruz River is heavily developed and channelized through Nogales, Sonora, and Nogales and Tucson, Arizona. Sewage effluents enter the Santa Cruz River from treatment plants in Nogales and Tucson. Throughout the watershed, the river is impacted by a wide variety of land uses that include, but may not be limited to: grazing, mining, groundwater pumping, urban developments, sewage treatment discharge and channelization.

Collection History
The earliest known collection of Gila chub from the Santa Cruz River was in 1891 by Jouy (Table C-15). It was also collected in 1893 and 1904. Although the ASU Museum Register obtained for this report did not list a collection location for ASU collection #7143, DeMarais (1986) indicated it was from the Santa Cruz River.

The Santa Cruz River, at the gaging station near Lochiel, Arizona was surveyed during Gila topminnow and/or FFC monitoring from 1988-1995. No Gila chubs were collected, however, the following species were collected: Gila topminnow, longfm dace, Sonora sucker, desert sucker, mosquitofish, green sunfish, largemouth bass and fathead minnow. Gila topminnow and mosquitofish also were collected from a connected backwater of the Santa Cruz River near Rio Rico, Arizona in 1994.

A hybrid of the two subspecies of pupfish known from Arizona (C. m. *macularius* and *C.* m. *eremus)* was stocked into BHWA in 1977. It also contains crappie, largemouth bass, green sunfish and mosquitofish. Pupfish were collected downstream, following their introduction, and upstream, in a drainage leading into BHWA in 1989 (Bagley et al. 1991). They have not been collected since from the drainage.

Recent Survey Results
The Santa Cruz River was not surveyed for this project.

Status, Threats and Management Recommendations
Extirpated (tentative). Gila chub is currently extirpated from the Santa Cruz River. It is still present in a tributary spring, Sheehy Spring, near the headwaters in the U.S. Management actions to remove nonnative fish and establishment of conservation easements that would improve habitat conditions in the Santa Cruz River within the San Rafael Valley may allow for the future reintroduction of Gila chub to that reach.

Cienega Creek

Site Description
Cienega Creek, Pima and Santa Cruz counties, Arizona is a tributary of the Santa Cruz River. It flows north between the Santa Rita and Empire mountains on the west and the Whetstone Mountains on the east, joining Pantano Wash near Vail, Arizona. The headwater elevation of Cienega Creek is about 1520 m (5000 ft), and it flows to an elevation of about 1070 m (3500 ft) at its confluence with Pantano Wash.

Land Ownership
Cienega Creek runs for a total of 34.9 km (21.7 mi) from the confluence with Spring Water Canyon downstream to Interstate 10. Cienega Creek is perennial for only a small portion of this reach. Land ownership along Cienega Creek comprises State (58 percent), BLM (37 percent) and private (5 percent) lands (Cienega Creek Land Ownership Map). The majority of the perennial portion of Cienega Creek is Federally owned and managed by BLM as the Empire-Cienega Resource Conservation Area.

Land and Water Uses
The BLM Empire-Cienega Resource Conservation Area (RCA) encompasses a majority of Cienega Creek currently occupied by Gila chub. The RCA is not grazed, mined or otherwise open to resource uses. The RCA is managed to preserve aquatic, riparian and wildlife values. There are no water withdrawal structures or other uses impacting the quantity or quality of water in Cienega Creek. Headwaters of the stream are grazed, but effects on the stream are unknown.

Collection History
Monitoring of Cienega Creek for the FFC in 1989, 1990, 1992 and 1993 resulted in the capture of Gila chub. Gila chubs have also been collected during annual monitoring for Gila topminnow in 1985, 1988, 1989, 1992 and 1995 (Table 9). The earliest reported collection of Gila chub in Cienega Creek was in 1969 by an unknown collector (Table C-16).

Recent Survey Results
Cienega Creek was not surveyed for this project. Sufficient information exists to summarize the present status of Gila chub, but not decreases in range or abundance, in Cienega Creek.

Status, Threats and Management Recommendations
Stable-Secure. Historical distribution and abundance information is insufficient to determine decreases in range or population abundance. Karen Simms (unpublished manuscript) conducted a survey from 1988 to 1990 of the Cienega Creek watershed to determine the presence of nonnative fishes in the watershed. The report identified 246 water sources within the **BLM Empire/Cienega Planning Area, of which 86 were sampled. Only two water sources were found to have nonnative fishes (largemouth bass, bluegill, goldfish, smallmouth bass and catfish). These nonnatives were found in tanks a significant distance from Cienega Creek, therefore Simms concluded that nonnative emigration from these areas into Cienega Creek was not a**

threat. The fmal results of that survey indicated a fairly low threat of exotic fish contamination from migration or surreptitious introduction from local sources. Simms concluded the most likely source of nonnatives would be by people stocking them from outside the watershed.

Table 9. Relative abundance of fishes collected during FFC and Gila topminnow monitoring in Cienega Creek, Santa Cruz County, Arizona in 1985-1995. Data are from AGFD NFDB. Species code abbreviations are defmed in Appendix A.

Date	Location	Project	Fish Collected (relative abundance), total n collected
850731	Cienega Creek, 31 49'30" 110 34'10"	Topminnow Mon.	POOC AGCH GUN
880818	T18S R17E S. 23 NE4 NE4	Topminnow Mon.	POOC (57%), AGCH (39%), GIIN (3%), n=376
890724	T18S R17E S.12 & 35 T19S R17E S.10	Topminnow Mon.	POOC (54%), AGCH (40%), GIIN (6%) n=946
891021	T18S R17E S. 23 NE4 SW4	Fall Fish Count	POOC (88%), AGCH (12%), GIIN (<1%), n=2589
901121	T18S R17E S. 23 SE4 SW4 T19S R17E S. 10 NE4 T19.5S R17E S. 15 SE4 SE4	Fall Fish Count	POOC (71%), AGCH (29%), GIIN (<1%) n=717
901130	T16S R17E S. 30 NE4 NE4 T16S R16E S.14 SE4 SE4 T16S R17E S. 19 SW4 SE4	Fall Fish Count	AGCH (100%) n=936
920618	T19S R17E S. 10 NE4	Topminnow Mon.	POOC (100%), n=69
921027	T18S R17E S. 12 NE4	Fall Fish Count	GIIN (55%), AGCH (36%), POOC (9%), n=94
921028	T19S R17E S. 15 SE4 SE4	Fall Fish Count	POOC (99%), GIIN (<1%), n=3224
921031	T19S R17E S. 10 NE4 SE4 T19S R17E S. 3 NE4 SE4	Fall Fish Count	POOC (97%), AGCH (3%), GIIN (<1%), n=7501
921110	T18S R17E S. 13 NE4 NW4	Fall Fish Count	AGCH (72%), POOC (27%), GIIN (1%), n=71
931012	T19S R17E S. 15 SE4 SE4	Fall Fish Count	POOC (98%), GIIN (2%), n=794
931013	T19S R17E S. 10 NE4 SE4 T19S R17E S. 3 NE4 SE4	Fall Fish Count	AGCH (61%), POOC (39%), n=896
931014	T18S R17E S.23 SW4 NE4 T18S R17E S. 23 NE4 SE4	Fall Fish Count	AGCH (89%), POOC (11%), GIIN (<1%), n=1724
931015	T18S R17E S. 13 NE4 NW4 T18S R17E S. 12 NE4 SE4	Fall Fish Count	AGCH (99%), GIIN (1%), n=370
931028	T19S R17E S. 15 NE4 NE4	Fall Fish Count	POOC (78%), GIIN (14%), AGCH (8%), n=450
940721	T19S R17E S. 15 NE4 SE4 T18S R18E S. 6 SE4 SW4	Topminnow Mon.	AGCH (79%), POOC (21%), n=400
950724	T18S R17E S. 14 SE4 SE4 T18S R17E S. 12 NE4 SE4	Topminnow Mon.	AGCH (58%), POOC (29%), GIIN (13%), n=857

Jeff Simms (BLM, pers. comm.) provided information delineating reaches of Cienega Creek occupied by Gila chub based on his personal observations and recent collections. Those reaches have been transferred to the Cienega Creek Land Ownership Map and are highlighted in blue. According to that information, of the approximately 39 km (24 mi) of Cienega Creek above Interstate 10, approximately 11 km (7 mi) are inhabited by Gila chub. This includes approximately 5 km (3 mi) of stream from 1.6 km (1.0 mi) above Gardner Canyon to Empire Ranch Road crossing, and 6 km (4 mi) of stream extending from 1.6 km (1.0 mi) above the confluence of Cienega Creek and Mattie Canyon downstream to The Narrows, as well as the lowest 1.6 km (1.0 mi) of stream in Mattie Canyon.

Jeff Simms (BLM, pers. comm.) Believes that the chub population is healthy and that pool habitat is abundant and stable. Headcut erosion has occurred that could potentially threaten approximately 4 km (3 mi) of chub habitat. BLM has taken steps that should eliminate that threat (constructed instream eosion control structures). The greatest threat to this chub population continues to be the potential for illegal introduction of nonnatives from outside the watershed.

Sabino Canyon

Site Description

Sabino Canyon is a tributary of Tanque Verde Wash and Rillito Creek in the Santa Cruz River drainage, Pima County, Arizona. Headwaters are in the Santa Catalina Mountains north of Tucson at an elevation of 2440 m (8000 ft), and it flows into Tanque Verde Wash in Tucson at an elevation of 770 m (2520 ft).

Sabino Creek drains an area of 91.94 km^2 (35.5 mi^2) and has an average gradient of 34 m/km (180 ft/mi). Substrates range from sand to boulder-bedrock. Discharge is often erratic, due to seasonal rain, snowfall and drought. Discharge averages 0.37 m^3/s (12.9 cfs), ranging from 0 to 218.9 m^3/s (0 to 7730 cfs) during 51 years of record (Dudley 1995).

Land Ownership

Land Ownership along Sabino Canyon within a 1.6 km (1.0 mi) buffer beginning at the confluence with Tanque Verde Wash and continuing upstream 29.5 km (18.3 mi) to the USGS gauging station at 2190 m (7200 ft) elevation comprises Coronado National Forest (67 percent) and private (33 percent) lands. Private lands on the Sabino Canyon Land Ownership Map are within the city limits of Tucson, Arizona, but private land is also present at the headwaters in Summerhaven, outside of the buffer zone.

Land and Water Uses

Headwaters of Sabino Canyon are developed within the residential community of Summerhaven. Downstream of Summerhaven, Sabino Canyon flows about 16 km (10 mi) through the Coronado National Forest, Pusch Ridge Wilderness Area, where wilderness recreation is the only impact. Sabino Canyon then enters the USFS Sabino Canyon Recreation Area where recreation is again the dominant land use. A paved access road is maintained by the USFS with nine bridged

crossings, each of which forms a formidable waterfall and barrier. Downstream from the recreation area, Sabino Canyon enters the Tucson city limits where land uses are mostly residential and industrial.

Collection History

The earliest known collection of Gila chub was in 1929 by Kranzther. Many collections were made in Sabino Canyon in subsequent years (Table C-17).

FFC surveys were conducted by AGFD personnel and volunteers in 1989, 1990 and 1992 through 1994 (Table 10). Dudley (1995) provided information on the progressive upstream movement of green sunfish over the past 12 years. Green sunfish were found above bridge one in 1982, above bridge four in 1983, above bridge six in 1984, above bridge seven in 1988 and above bridge eight in 1994. FFC surveys also reported green sunfish above bridge eight in 1993. People are suspected of moving green sunfish above the barriers.

Table 10. Summary of Fall Fish Count surveys in Sabino Canyon, Pima County, Arizona 1989-1994. Locations arranged from downstream to upstream. Species code abbreviations are defined in Appendix A.

Location	891025	901029	921109	930603	940111	941018
Forest Service Boundary (southern)	GAAF (86%) LECY (14%) n=123	LECY (78%) GAAF (20%) MISA (2%) n=45	GAAF (65%) LECY (35%) n=178		LECY (100%) n=53	LECY (100%) n=123
South of Bear Canyon Road Bridge	GAAF (93%) LECY (7%) n=133	GAAF (56%) LECY (42%) MISA (2%) n=86		LECY (100%) n=25		
Below Bridge 1			LECY (85%) GAAF (15%) n=96		LECY (93%) GIIN (7%) n=27	LECY (100%) n=51
Above Bridge 3		LECY (100%) n=30		GIIN (na) LECY (na)		
Below Bridge 5		LECY(100%) n=17				LECY (62%) GIIN (38%) n=21
Below bridge 6 or 7			LECY (100%) n=23	GIIN(88%) LECY (12%) n=9	LECY (100%) n=21	LECY (71%) GIIN (29%) n=21
Below bridge 8			LECY (50%) GIIN (50%) n=12		LECY (100%) n=56	
Between bridges 8 and 9	None collected	GUN (100%) n=14		GIIN (66%) LECY (34%) n=9	GIIN (65%) LECY (35%) n=34	
Above Bridge 9			GUN (100%) n=199	GIIN (100%) n=102		GIIN (100%) n=15

Investigations into interactions between Gila chub and green sunfish were conducted by Dudley (1995). He reported static distributions of Gila chub and green sunfish during the period of study (fall 1993 to fall 1994). Gila chubs were found in lower densities in lower Sabino Canyon where green sunfish were more abundant. Habitats without green sunfish held more Gila chub. Also, no Gila chub under 40 mm (1.6 in) total length were observed anywhere in Sabino Canyon where they were sympatric with green sunfish, although they were observed in habitats not occupied by green sunfish. Dudley reported that green sunfish as small as 51 mm (2 in) total length readily preyed on young Gila chub 20 to 25 mm (0.8 to 1.0 in) total length, and that the presence of Gila chub in lower Sabino Canyon is the result of dispersal from upstream, not the result of reproduction and recruitment in lower Sabino Canyon.

Recent Survey Results

Sabino Canyon was not surveyed for this project.

Status, Threats and Management Recommendations

Unstable-Threatened. Gila chub is limited in distribution by green sunfish. Currently, green sunfish distribution in Sabino Canyon is restricted to below bridge nine. There is a barrier to upstream movement of fish between bridges eight and nine that appears to be halting upstream movements. The uppermost distribution of Gila chub in Sabino Canyon is currently unknown. There is a high probability that green sunfish will be moved upstream of bridge nine by well-meaning, but poorly informed, Sabino Canyon visitors. Informational signs within the recreation area may assist in educating the visitors. The long-term stability of this population is in question due to the continued invasion of green sunfish and subsequent declines in Gila chub abundance. Attempts should be made by AGFD and Coronado National Forest to remove green sunfish from as much of lower Sabino Canyon as possible.

Sonoita Creek

Site Description

Sonoita Creek, Santa Cruz County, Arizona is a tributary of the Santa Cruz River. Much of Sonoita Creek is dry throughout most of the year. Less than ten linear miles of perennial flow remain. The creek flows from an elevation of 1,460 m (4800 ft) at its origin, to an elevation of 1050 m (3440 ft) at the Santa Cruz River confluence. Monkey Spring is in a tributary of Sonoita Creek at an elevation of 1390 m (4550 ft). Monkey Spring has rich aquatic vegetation, which includes: *Lilaeopsis recurva, Ludwigia natans* (recorded in Arizona only from Monkey and Cottonwood Springs), unidentified mosses, *Potamogeton foliosus,* the sometimes emergent *Hydrocotyle verticilliata* and *Chara* spp. (Minckley 1969). Minckley (1969) reported Monkey Spring water temperatures at the source spring to average about 82 F. The pH at the source ranged form about 6.8 to 7.0. Monkey Spring has no detectable turbidity and dissolved oxygen concentrations were low (2.3 to 2.6 mg/l). Hendrickson and Minckley (1984) provide a more complete description of historical and present habitat conditions.

Land Ownership

A Land Ownership Map was not produced for this stream because Gila chub is considered extirpated (Minckley 1973). Sonoita Creek ownership is shared by TNC, ASLD, ASPD and private holdings. Many of the Sonoita Creek tributaries originate in the Coronado National Forest, but Sonoita Creek does not flow through it. Monkey Spring is privately owned and access to it is controlled by the landowner.

Land and Water Uses

Habitat changes occurred in Sonoita Creek as early as the 1890s. Adverse effects from arroyo cutting included bank erosion, moving sand bottoms and invasion of floodplains by extensive woody vegetation. Beginning at the headwaters near Sonoita, the creek is dry until nearing Cottonwood Spring. The spring provides some surface water to the creek, which flows for about 400 m, but most of the flow is diverted to downstream water users via an underground pipe. The stream then becomes ephemeral again due to course substrates, which allow percolation of surface flow. The stream remains dry until near Patagonia, where a wastewater treatment facility provides more surface flow. The stream remains perennial for many miles, through the TNC Sonoita Creek preserve to Patagonia Lake and further downstream, where groundwater maintains surface flow. Within three miles of the confluence with the Santa Cruz River, it again sinks into the stream bottom.

Collection History

Gila chub probably inhabited Sonoita Creek at some point in history (Minckley 1969), but no known specimens or observations exist. The species was abundant in Monkey Spring and in a natural travertine pond on the Rail-X Ranch, seven miles northeast of Patagonia, Arizona. Gila chub also inhabited a man-made reservoir fed by Monkey Spring. Miller (1961) reported data from surveys conducted by Chamberlain in the Sonoita drainage in 1904. *Gila* specimens from Monkey Spring, housed at the SMNH, were identified as *G. robusta* (Table C-18). Sonoita Creek surveys were continued from 1928 to 1959, principally by C.E. Burt, C.L. Hubbs and R.R. Miller (Minckley 1969). In 1938, Hubbs and others collected *Gila* specimens from Monkey Spring, which were identified as *G. robusta.* Miller and others collected *Gila* specimens in a reservoir fed by Monkey Spring in 1950, and again they were reported as *G. robusta.* Minckley periodically surveyed Sonoita Creek from 1963 to 1969, with an intensive survey conducted in 1967. In 1964 and 1967, he identified Monkey Spring specimens as *G. intermedia.* Separate collections in 1966 by Barber and Koehn, housed at ASU, were also identified as *G. intermedia.*

The Monkey Spring Gila chub population became extirpated between 1969 and 1973, following the 1968 introduction of largemouth bass (Minckley 1969, 1973). AGFD conducted monitoring of Gila topminnow in Monkey Spring (1985, 1989 and 1991-1995) and Sonoita Creek (1985, 1988, 1989 and 1991-1995), with no Gila chub caught or observed. TNC monitoring (Gori 1993) and FFC surveys (AGFD NFDB) in Sonoita Creek in 1989 and 1990-1994 again showed no Gila chub present.

Native fishes collected from Sonoita Creek (including Monkey Spring) include Gila topminnow, longfm dace, desert sucker, speckled dace, Gila chub and Monkey Spring pupfish (an undescribed *Cyprinidon* species). Nonnative species collected from Sonoita Creek include red shiner, mosquitofish, green sunfish, yellow bullhead, largemouth bass, bluegill, channel catfish, flathead catfish (stocked in Patagonia Lake by AGFD in 1977 and collected below the lake during 1992 FFC surveys) and Yaqui catfish (stocked in the pond below Monkey Spring, but since extirpated) (Minckley 1969).

Recent Survey Results
Surveys were not conducted in Sonoita Creek for this project.

Status, Threats and Management Recommendations
Extirpated. Based on available information, Gila chub is considered extirpated from Monkey Spring and Sonoita Creek. It is unlikely that suitable habitat will again be available in Monkey Spring for reintroduction of Gila chub.

Sheehy Spring

Site Description
Sheehy Spring, Santa Cruz County, Arizona lies adjacent to the Santa Cruz River in the San Rafael Valley near Lochiel. Available habitat is limited to one large pool and several smaller ones in a spring-fed cienega. Bagley et al. (1991) reported that the largest pool was 15 m long x 4 m wide x 2.2 meters deep (49 ft long x 13 m wide x 7.2 m deep). Thick blackberry bushes and ornamental trees effectively protect the large pool from direct impacts by grazing cattle. Elevation at the spring is 1425 m (4675 ft).

Land Ownership
Land ownership within a radius of one mile around the spring is entirely private and managed by the San Rafael Cattle Company.

Land and Water Uses
The spring is modified, dammed and transported through culverts and ditches for agricultural purposes by the private landowner. The cienega and surrounding grasslands are grazed by cattle on a rotational basis. Grazing duration, season and stocking rates are unknown.

Collection History
Gila chubs were first collected from Sheehy Spring in 1939 (Table C-19). Early collections in UMMZ refer to specimens as *G. robusta* or *G. r. intermedia,* however they subsequently have been identified as *G. intermedia* **(Minckley 1973; Rinne 1976; DeMarais 1986, 1992). The spring also provided habitat for the endangered Gila topminnow. Sheehy Spring has been monitored periodically since its discovery, usually to determine the status of topminnow. Mosquitofish were first reported from Sheehy Spring above the small dam in 1979 (Meffe et al. 1983). Prior to this they were commonly found below the dam and in the Santa Cruz River**

(Minckley et al. 1977). Topminnow declined following the introduction of mosquitofish, until they disappeared in 1988 (Bagley et al. 1991).

Minckley et al. (1977) reported capturing 85 Gila chub above the dam and 22 below using electrofishing gear. FFC volunteers monitoring Sheehy Spring reported capturing nine Gila chub in 1989 and one in 1991, using seines and dipnets.

Recent monitoring by the AGFD (1985 to present), using seines and dipnets, has focused on searching for remaining topminnow, with Gila chub collection being incidental. Methods used during topminnow monitoring vary widely, and collections of Gila chubs are not directly comparable. AGFD records report collecting Gila chub during topminnow monitoring in 1994 (n=5) and in 1995 (n=6). Lack of collection of Gila chub in previous years may be the result of sampling technique bias or a failure by surveyors to report their presence. These numbers indicate a small Gila chub population in a confined habitat; however, no attempts have been made to determine actual population size.

Recent Survey Results
Sheehy Spring was not surveyed for this project.

Status, Threats and Management Recommendations
Unstable-Threatened. Gila chub presence has been documented since 1939. Lack of historical or current population estimates precludes determining a trend for this population. Mosquitofish is likely having an adverse impact on the survival of Gila chub larvae and recruitment. Renovation of this spring to remove mosquitofish and provide habitat for Gila topminnow has been discussed, but habitat complexity and private ownership complicate matters.

This is the only known population of Gila chub in the upper Santa Cruz River. Population size estimates should be conducted to determine if there is suitable reproduction and recruitment to allow removing Gila chub for reintroduction to other suitable sites in the upper Santa Cruz River watershed.

San Pedro River

Site Description
The San Pedro River originates in desert grasslands near Cananea in northern Sonora, Mexico, crossing the international border and flowing through Cochise, Pima, and Pinal counties, Arizona to its juncture with the Gila River. The river begins at an elevation of 1300 m (4275 ft) and joins the Gila River at an elevation of 548 m (1800 ft) near Winkelman, Arizona. The watershed encompasses more than 10,700 km^2 (4000 mi^2). Elevations within the watershed range from 2250 m (7400 ft) to 548 m (1800 ft) at the river's mouth. The San Pedro River flows about 225 km (140 mi) through structural basins with alluvial fill exceeding 300 m (1000 ft).

Most of the San Pedro River today is incised, nearing 4 m (13 ft) where the floodplain is narrow. Annual discharge measured at Charleston, Arizona averaged 59 cfs over a 65 year period (Jackson et al. 1987). Flow patterns are sharply bimodal with flooding in winter and summer separated by periods of drought in spring and fall. Present riparian vegetation consists of cottonwood, Gooding willow, seep willow, mesquite, several grasses and the nonnative salt cedar. For a more complete description of historic and present habitats, see Hendrickson and Minckley (1984) and Jackson et al. (1987).

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer zone along the San Pedro River from the Arizona-Mexico boundary north to Redington, Arizona comprises private (41 percent), BLM (34 percent), State (24 percent) and United States Army, Fort Huachuca (> 1 percent) lands (San Pedro River Land Ownership Map). Lands in Sonora, Mexico (about 1803 km^2 [696 mi^2] of the San Pedro River watershed) are privately owned ranches and mines with limited access. BLM lands along the San Pedro River from the international border upstream to near St. David were designated as a Riparian National Conservation Area (RNCA) by Congress in 1988. There are several Research Natural Areas (RNA) within the RNCA. North of St. David downstream to Redington, lands along the river channel are primarily private. Uplands away from the river belong to the ASLD.

Land and Water Uses

Land and water uses within the San Pedro River watershed include agriculture, mining, grazing, logging, industrial, municipal, residential, recreation and wildlife. Appropriated water rights, as governed by state law, are beyond the scope of this report. Some of the known factors that directly affect water quality and fish are the Cananea mine in Mexico, San Manuel copper mine, groundwater withdrawals for agriculture and municipal uses and sewage effluent from communities in Mexico and Arizona.

Collection History

The San Pedro River historically supported at least 13 native fish species (Jackson et al. 1987). Gila chubs were first collected from the San Pedro River by J.H. Clark in 1851. Later collections occurred at Fairbanks, Arizona and 2.5 km (1.5 mi) above Fairbanks (Chamberlain 1904) and at St. David, Arizona in 1912 by the U.S. Bureau of Fisheries (Table C-20). SMNH museum collections identify *Gila* specimens from the upper San Pedro River as *G. r. intermedia*. Rime (1969, 1976) identified chubs from the upper San Pedro River drainage as *G. intermedia* based on specimens from Bass, Redfield, Turkey and O'Donnell canyons and the Babocomari River. Based on these collections and additional information (Minckley 1973; DeMarais 1986, 1992) Gila chub historically occupied the upper San Pedro River. Downstream portions of the San Pedro River nearing the Gila River, including Aravaipa Creek, contained *G. robusta* that were phenotypically intermediate between the two species (based on the distribution of the species in tributaries to the San Pedro River as described by DeMarais 1986).

Surveys conducted in 1990 at eight locations from Hereford downstream to St. David reported only two native species, longfin dace and desert sucker (Stefferud and Stefferud 1990). Nonnative fish collected included mosquitofish, black bullhead and fathead minnow.

Fish collected during FFC surveys near the Highway 90 bridge (1988 to 1991) and near the Charleston Road bridge (1988 to 1991) included longfin dace, desert sucker, yellow bullhead, mosquitofish, fathead minnow and black bullhead.

From May 1988 to May 1992, nine sites were surveyed along the San Pedro River, Sonora, Mexico. In 1990, Gila chubs were found at two cienega sites, Cienega los Fresnos (31° 19'N and 110 26'W) and Cienega la Cienegita. Both populations were associated with spring-fed cienegas isolated from the San Pedro River by extensive dry stretches (Varela-Romero et al. 1992; Gori 1993). A main channel joins Cienega los Fresnos to the Arroyo los Fresnos, a tributary of the San Pedro River 2.0 km (1.2 mi) south of the international boundary. This Gila chub population appeared small, but healthy, with multiple age classes. No nonnative fish were caught. Cienega la Cienegita had a small Gila chub population associated with two nonnative species: mosquitofish and green sunfish. The introduced species dominated the fish assemblage. There are no other published records indicating Gila chub presence in Mexico (Varela-Romero et al. 1992).

Recent Survey Results

Surveys by Alejandro Varela-Romero in 1995 in Sonora, Mexico, again confirmed the presence of Gila chub in the fore-mentioned cienegas of the San Pedro River (Francisco Abarca, AGFD, pers. comm.). No surveys of the San Pedro River in the United States were conducted for this review.

Status, Threats and Management Recommendations

Unstable-Threatened in Mexico, and Extirpated in the U.S. Although Gila chub currently appears to be extirpated from the San Pedro River in the United States, habitat improvements expected within the BLM San Pedro RNCA may allow for the future reintroduction of the species and other native fishes. Continued availability of in-stream flows within the San Pedro RNCA is unknown and flows may be heavily impacted by continued development in Sierra Vista and surrounding communities.

Varela-Romero (1992) concluded that distribution and abundance of native species in the San Pedro River, Sonora, Mexico was related to the availability of unaltered aquatic habitat. The future of the two known Mexican Gila chub populations is questionable. Nonnative fishes are established throughout the San Pedro River watershed, including tributaries containing known Gila chub populations. Green sunfish pose the greatest threat to the Cienega la Cienegita Gila chub population due to their aggressive predatory nature and large size. Only three adult Gila chubs were caught in La Cienegita in 1990, causing concern over the current status of this population.

Additional concerns for Gila chub survival in Mexico include increasing water use for agriculture and urban development. These impacts will reduce the amount of aquatic habitat and modify natural flow regimes, making streams more vulnerable to nonnative fish encroachments. Green sunfish and Gila chub population dynamics need to be monitored to assess continued Gila chub existence. Extreme pollution from the Cananea mine occurred in 1979, and although leaching ponds have since been secured, there is the threat of more pollution problems from the extensive, open pit copper mines (Jackson et al. 1987).

Redfield Canyon

Site Description

Redfield Canyon, Graham and Pima counties, Arizona, is a west flowing tributary to the San Pedro River. Redfield Canyon originates in the southern portion of the Galiuro Mountains near an elevation of 1520 m (5000 ft) and meets the San Pedro River near Redington, Arizona at an elevation of 880 m (2900 ft). Perennial flow in Redfield Canyon begins at the confluence with Sycamore Creek and terminates before its confluence with the San Pedro River. A 5 m (16 ft) high waterfall was present in Redfield Canyon in 1983 at a point 0.7 km (0.43 mi) below the mouth of Sycamore Canyon. The waterfall effectively prevented fishes from dispersing above that point (Griffith and Tiersch 1989).

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along Redfield Canyon beginning at the confluence with the San Pedro River and continuing 30.9 km (19.2 mi) upstream comprises State (55 percent), private (20 percent), USFS (16 percent) and BLM (8 percent) lands. Private lands and an unknown percentage of federal lands (USFS and BLM) are included in the management of TNC's Muleshoe Ranch Nature Preserve.

Land and Water Uses

Low level livestock grazing occurs in the Redfield Canyon drainage. A limited amount of ORV use may be present along the lower canyon, accessed from Cascabel Road; however, this is downstream from the perennial reach. Impact from two small mining claims in the upper drainage is unknown, but should be minimal. TNC lands are managed for the conservation and preservation of natural resources. No other land or water uses are known in Redfield Canyon. Perennial portions of Redfield Canyon (Gori 1993) are shown on the Land Ownership Map.

Collection History

The first documented collection of Gila chub in Redfield Canyon was in 1961 (Table C-21). A number of collections of Gila chub occurred from 1976 through 1983. Associated species collected included longfin dace, Sonora sucker and speckled dace.

Redfield Canyon contains one of the few populations of Gila chub for which population studies have been conducted (Griffith and Tiersch 1989). Scale analysis indicated that there were four age classes of Gila chub present in May 1983, with mean lengths of 90, 135, 160 and 183 mm

(3.5, 5.3, 6.3 and 7.2 in). Based on the size range of age 1 fish (45-111 nun [2-4 in]), spawning was hypothesized to occur over a long period. Male and female Gila chubs were reaching sexual maturity at the end of their first year, with the smallest ripe males and females measuring 90 to 95 mm (3.5 to 3.7 in) in total length. Density estimates (fish/100 m^2) for Gila chub at two separate locations were 41 in pools and 41 in riffles at an upper site, and 11 in pools and 2 in riffles at a site downstream. Griffith and Tiersch (1989) found a strong linear relationship between depth of pools and total length of largest Gila chub present in the pool.

FFC sites were established and surveyed by volunteers from 1988 through 1990 (Table 11). Gila chubs were collected each year, however they were found in relatively low numbers (2 percent, 2 percent and <1 percent, respectively). Other native fish included longfm dace, Sonora sucker, desert sucker, speckled dace and sucker hybrids (Sonora x desert). Nonnative fish included green sunfish and fathead minnow. In 1990, green sunfish comprised up to 15 percent of the total catch.

TNC established monitoring stations which were surveyed from 1991 through 1994. Gila chubs were caught each year (Table 11). They were the most abundant species caught in 1991 (72 percent), 1992 (42 percent) and 1994 (33 percent), and equal to longfin dace (30 percent) in 1993. Other native fish caught included Sonora sucker, desert sucker and speckled dace. Green sunfish was the only nonnative fish caught, and then only in relatively low numbers (<1 to 3 percent). Green sunfish was not collected in 1993 and 1994. The differences between FFC (1988 to 1990) and TNC collections (1991 to 1994) in relative abundance of green sunfish is best explained by the difference in collection locations. The FFC sites were several miles downstream of TNC monitoring locations.

Table 11. Survey results in Redfield Canyon, Graham and Pima counties, Arizona, for Fall Fish Count and The Nature Conservancy annual monitoring. Species code abbreviations are defined in Appendix A.

FFC T11S R19E Sec. 35	1988 (n=228)	1989 (n=102)	1990 (n=637)	
	AGCH (74%) CAIN (12%) PACL (8%) RHOS (4%) GUN (2%) LECY (<1%) PIPR (<1%) PAxCA (<1%)	AGCH (77%) LECY (8%) CAIN (5%) PACL (4%) RHOS (4%) GILA (2%)	AGCH (67%) LECY (15%) PACL (14%) CAIN (2%) RHOS (1%) GUN (<1%) PAxCA (<1%)	
TNC T11S R20E Sec. 28 & 32	1991 (n=568)	1992 (n=308)	1993 (n=523)	1994 (n=523)
	GILA (72%) CAIN (14%) AGCH (7%) RHOS (7%) LECY (<1%)	GILA (42%) CAIN (22%) RHOS (22%) AGCH (10%) LECY (3%) PACL (<1%)	AGCH (30%) GILA (30%) RHOS (28%) CAIN (12%)	GILA (33%) RHOS (28%) AGCH (22%) CAIN (17%)

Recent Survey Results
Based on the amount and quality of information available from TNC annual monitoring, Redfield Canyon was not surveyed for this project.

Status, Threats and Management Recommendations
Stable-Threatened. Gila chub is relatively abundant in the perennial portion of Redfield Canyon, about seven miles of stream. The only known threat to the chub in this creek appears to be the presence of nonnative green sunfish, which have been more abundant in downstream portions than in upstream areas. Green sunfish was not collected following severe flooding, which occurred in the winter of 1992 to 1993. Continued monitoring is recommended to determine the threat that green sunfish pose to Gila chub. Management by TNC, the remoteness and rough terrain, plus the location of wilderness area in the upper drainage should prevent further habitat degradations.

Bass, Hot Springs and Double R Canyons

Site Description
Bass Canyon is a perennial stream in Graham and Cochise counties, Arizona. It is a tributary of Hot Springs Canyon, which flows into the San Pedro River at Cascabel. Double R Canyon is a tributary of Bass Canyon. These streams flow south and westerly and drain the southern edge of the Galiuro Mountains and the western edge of the Winchester Mountains. Elevations within the drainage range from 1905 m (6250 ft) at Bass Canyon headwaters and 1370 m (4500 ft) in Double R Canyon down to 1200 m (3950 ft) at the confluence of Bass and Hot Springs canyons and 960 m (3150 ft) at the confluence of Hot Springs Canyon and the San Pedro River.

Land Ownership
Land ownership was calculated for Bass Canyon from its confluence with Hot Springs Canyon upstream 6.1 km (3.8 mi) (Bass Canyon Land Ownership Map). This area includes most of Double R Canyon and approximately 3.2 km (2 mi) of Hot Springs Canyon near the confluence with Bass Canyon. Ownership comprises BLM (62 percent), private (31 percent), and State Trust (7 percent) lands. The deeded lands are owned by TNC and are included in the Muleshoe Ranch TNC Preserve.

Land and Water Uses
The primary use of private lands is as a nature preserve, promoting conservation and preservation of natural resources. Land within the watershed owned by BLM or ASLD is leased for cattle grazing. Water uses are limited to withdrawals necessary for cattle operations and the remainder is left for instream flow maintenance and use by wildlife. Known areas of perennial and ephemeral flow in Bass, Hot Springs and Double R canyons were transferred to the Land Ownership Maps from Gori (1993).

Collection History

Bass, Hot Springs and Double R canyons in Graham and Cochise counties, Arizona all supported Gila chub at some point in recent history. Gila chubs are commonly found in Bass Canyon, and during wetter seasons in Hot Springs and Double R canyons near their confluence with Bass Canyon.

The first documented collection of Gila chub was made in 1977 by Thompson (Table C-22). Other species collected at the same location and date were desert sucker and speckled dace. Subsequent collections by Mills in 1980 did not report associated species. Johnson (1983) reported longfin dace (80 percent), Gila chub (8 percent), desert sucker (6 percent), speckled dace (3 percent), and Sonora sucker (3 percent) in Bass Canyon during April, May, and June 1983.

AGFD FFC surveys in Bass Canyon were conducted by volunteers in 1988 and 1989. In 1988, several locations in Bass Canyon were sampled and the following fish were collected (n=1055): longfin dace (95 percent), Gila chub (2 percent), desert sucker (1 percent), speckled dace (1 percent), and Sonora sucker (<1 percent). The following species were collected from Bass Canyon in 1989 below Patterson's cabin; longfm dace (52 percent), Gila chub (21 percent), speckled dace (19 percent), desert sucker (6 percent), Sonora sucker (2 percent), and largemouth bass (< 1 percent) (total n=251).

Beginning in 1991, biologists with TNC established eight fixed sample stations in Bass Canyon, five in Hot Springs Canyon, and three in Double R Canyon. Selected stations have been monitored annually since 1991 (Table 12). Random pools also were sampled in the streams each year beginning in 1992. In Bass Canyon, Gila chubs were collected in all four years (1991 to 1994) of monitoring. In Hot Springs Canyon, Gila chubs were collected in three (1991, 1993, and 1994) of the four years. In Double R Canyon, Gila chubs were only collected in two (1993 and 1994) of the four years of monitoring.

Recent Survey Results

Based on the amount and quality of information available from the TNC Annual Monitoring, Bass Canyon, Hot Springs Canyon, and Double R Canyon were not surveyed for this project.

Status, Threats and Management Recommendations

Stable-Threatened. Gila chubs are uncommon, but usually present, elements of the fish community in Bass Canyon. Gila chubs appear to be less consistently present in Hot Springs and Double R canyons. Relative abundance of Gila chub appears to fluctuate yearly, likely based on local environmental conditions. Due to a lack of long-term data, it is not possible to determine if there have been declines in the distribution or abundance of Gila chub in Bass, Hot Springs, or Double R canyons. Habitat availability appears limited by seasonal fluctuations of surface water.

Table 12. Relative abundance of fishes collected from Bass, Hot Springs, and Double R canyons during TNC monitoring 1991-1994. Species code abbreviations are defined in Appendix A.

Stream/Year	1991	1992	1993	1994
Hot Springs Canyon	AGCH (63%) PACL (19%) RHOS (17%) CAIN (<1%) GIIN (<1%) (n=1521)	AGCH (58%) RHOS (35%) PACL (7%) CAIN (<1%) (n=1671)	AGCH (51%) PACL (25%) RHOS (21%) CAIN (2%) GIIN (<1%) (n=4262)	AGCH (59%) RHOS (21%) PACL (17%) CAIN (1%) GIIN (<1%) (n=2118)
Bass Canyon	AGCH (55%) GIIN (20%) PACL (16%) CAIN (5%) RHOS (4%) (n=490)	AGCH (60%) RHOS (23%) PACL (14%) GIIN (2%) CAIN (<1%) (n=1550)	AGCH (46%) RHOS (36%) PACL (13%) GIIN (5%) CAIN (<1%) (n=1400)	AGCH (57%) RHOS (24%) PACL (12%) GIIN (4%) CAIN (2%) (n=2004)
Double R Canyon	AGCH (70%) RHOS (30%) (n=508)	AGCH (53%) RHOS (47%) (n=176)	RHOS (85%) AGCH (15%) GIIN (<1%) (n=241)	AGCH (88%) RHOS (8%) PACL (3%) GIIN (<1%) (n=383)

The presence of largemouth bass, collected in 1989, is a cause of some concern. Even though they have not been collected since, there may be a source of nonnatives in the watershed. It should be surveyed and an attempt made to remove any nonnatives present. There is also the potential for nonnatives to move up Hot Springs Canyon and into Bass Canyon from the San Pedro River, but probably only during long term, low discharge flood events that connect Hot Springs Canyon to the San Pedro River. The inhabited stream is owned and managed by TNC and should remain protected from habitat degradation. Annual monitoring should be continued.

Babocomari River

Site Description

The Babocomari River is a tributary of the San Pedro River in Santa Cruz and Cochise counties, Arizona. It flows from west to east beginning near Elgin, Arizona and joins the San Pedro River near Fairbanks. The watershed consists of southern portions of the Mustang and Whetstone Mountains and northern portions of the Canelo Hills and Huachuca Mountains. The Babocomari River flows from an elevation nearing 1525 m (5000 ft) at its headwaters to 1165 m (3825 ft) at the confluence with the San Pedro River. It historically flowed through continuous cienegas and marshes to the San Pedro confluence, but arroyo cutting destroyed all but one area at the Babocomari Ranch, which was protected by a large dam constructed in the 1930s (Hendrickson

and Minckley 1984). The cienega is privately owned and has been proposed for preservation as a Natural Area (Smith and Bender 1974).

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along the Babocomari River, beginning at its confluence with O'Donnell Canyon and continuing downstream to the San Pedro River, is predominantly private (63 percent). Other land owners are BLM (18 percent), ASLD (11 percent), and the U.S. Army, Fort Huachuca military base (8 percent).

Land and Water Uses

Headwaters of the Babocomari River are ephemeral. Perennial water begins near the Babocomari Ranch. During 1995 surveys by AGFD, the only water use observed was a large impoundment in the Babocomari River, on the Babocomari Ranch. Perennial surface flow begins just upstream from this impoundment near T-4 Spring. No diversions or pumps were noted around the impoundment and no other impoundments, diversions or impacts were noted downstream. During normal years, surface flow extends for only a few miles below the impoundment (Frank Brophy, owner, pers. comm.). The remainder of the Babocomari River downstream is ephemeral. During wetter periods, it may extend through Huachuca City to the San Pedro River. An historic Southern Pacific Railroad line runs the entire length of the Babocomari River with two bridged crossings near the Babocomari Ranch. The railroad tracks have been removed and the elevated grade has been converted to an unpaved road.

Collection History

Gila chubs were first collected from the Babocomari River in 1892 near Fort Huachuca (Table C-23). The next documented collection was in 1950, 5.6 km (3.5 mi) below the Babocomari Ranch. Nonnative fishes first appeared in museum collections in the late 1960s. The following nonnatives have been collected in the Babocomari River: largemouth bass, bluegill, goldfish, and yellow bullhead. Other native species documented in the Babocomari River are desert sucker, Sonora sucker and longfin dace.

Data collected by AGFD Fall Fish Count (FFC) volunteers in 1988 indicated Gila chub and longfin dace presence only in T-4 Spring. Relative abundances calculated from their data (n=142) were 51 percent Gila chub and 49 percent longfm dace. They also sampled 1.6 km (1.0 mi) downstream of the dam and 200 m (660 ft) upstream of the dam, in an isolated backwater, but found only largemouth bass and yellow bullhead.

Recent Survey Results

In 1995, the only native fish collected in the Babocomari River below the Babocomari Ranch impoundment was Sonora sucker (5 percent). Nonnatives included largemouth bass (46 percent), mosquitofish (41 percent), green sunfish (6 percent), and bluegill (1 percent) (total n=111). Mosquitofish were more abundant than sampling indicated, due to bias of electroshocking gear and dipnetters who avoided netting schools of mosquitofish to focus on areas with higher potential of producing Gila chubs.

Sampling conducted downstream from the ranch near Huachuca City and at the confluence with the San Pedro River resulted in the capture of longfm dace (34 percent), fathead minnow (23 percent), mosquitofish (20 percent), green sunfish (14 percent), Sonora sucker (4 percent), and desert sucker (3 percent) (total n=159).

Middle portions of the Babocomari River below the Babocomari Ranch impoundment were greatly incised and the flood plain was very narrow. The riparian gallery was generally well developed and, where terraces were present, dominated by mature cottonwoods and willows. Wider, less incised ephemeral channel reaches were dominated by shrubs and grasses and lacked a riparian overstory. Root wads and woody debris were abundant within the riparian gallery and provided some cover for fish. Banks were generally vertical and undercut to varying degrees, and stabilized by roots of grass and other vegetation. The dominant habitat type available was pool, with few riffles and some short runs. Substrates were dominated by silt in the pools and by gravels and pebbles in the short reaches of riffle separating each pool. Long, slow-moving runs were also abundant and consisted of mostly sand/gravel substrates. Overall, this stream appeared to provide suitable habitat for Gila chub, although none were collected.

Status, Threats and Management Recommendations

Unstable-Threatened. Historical information on distribution and abundance of Gila chub is insufficient to determine declines in abundance. Gila chub is believed extirpated from the Babocomari River below the Babocomari Ranch impoundment, but extensive inventories are necessary. The presence of nonnative competitors, especially largemouth bass, in the impoundment and river downstream make it unlikely that chub could naturally disperse from T-4 Spring and re-populate the river. Minckley (1973) stated that largemouth bass had eliminated a species of *Gila* from the pond below Monkey Spring. Restoring Gila chub to the Babocomari River would require removal of largemouth bass and other nonnatives from the impoundment and river downstream, which are privately owned.

Currently, Gila chub distribution in the Babocomari River is believed restricted to T-4 Spring (NFDB 1988). The habitat available in the spring is currently very limited by lack of surface water (Frank Brophy, owner, pers. comm.). Size and age-class structure are not known, and more information is necessary to determine future viability of this restricted population. In order to preserve this small population, steps might be taken to accomplish a conservation agreement with the land owner to preserve the integrity of the spring and the immediate surrounding area.

O'Donnell Canyon and Post Canyon

Site Description

O'Donnell Canyon, Santa Cruz County, Arizona is a tributary of the Babocomari River, which flows into the San Pedro River. O'Donnell Canyon originates in the northern portions of the Canelo Hills at about 1600 m (5250 ft) in elevation and flows north to its confluence with the Babocomari River at 1390 m (4550 ft).

Post Canyon is a tributary of O'Donnell Canyon, and has one reach of stream which is perennial except during extreme periods of drought. There is a large dam (approximately 20 ft high) in the Post Canyon drainage at the western edge of T21S R18E, Sec. 28, which forms a large pond. Above and below the pond are short reaches of connected scour pools, which form the perennial portions of stream.

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along O'Donnell Canyon, beginning at the confluence with the Babocomari River and continuing upstream to near the confluences of Western, Pauline and Middle canyons comprises private (46 percent), Coronado National Forest (40 percent) and BLM (14 percent) lands (O'Donnell Canyon Land Ownership Map). Portions of O'Donnell Canyon are managed privately by TNC within the Canelo Hills Cienega Preserve. An unknown percentage of federal lands (BLM and USFS) as well as private land are managed by the National Audubon Society's Appleton-Whittel Research Ranch (boundary is outlined in blue on the Land Ownership Map). The perennial portions of Post Canyon are included within the one mile buffer around O'Donnell Canyon and are owned by, or managed as part of, the Audubon Research Ranch.

Land and Water Uses

Perennial water begins at springs on the Canelo Hills Cienega Preserve and continues downstream into the southern portions of the Audubon Research Ranch (perennial reach provided by Gori (1993) is shown on the Land ownership Map). Those portions of O'Donnell Canyon on the Canelo Hills Cienega Preserve and the Audubon Research Ranch are managed to preserve natural habitats and wildlife. Livestock grazing on these properties does not occur; however, the upper portions of the watershed on private and USFS property are grazed. Several dams exist, including a series of earthen check dams in the vicinity of the dorm house on the Research Ranch and two cinder block dams on the southern portion of the ranch. A cement barrier was constructed on the Canelo Hills Cienega Preserve to prevent upstream head-cutting and protect the cienega.

Collection **History**

The first documented collection of Gila chub from O'Donnell Canyon was in 1977 by O'Brien and Ginnelly (Table C-24). Other species reportedly collected at the same location and date were longfm dace and Sonora sucker. Subsequent collections by Johnson (1978) and DeMarais in 1983 did not report associated species.

AGFD conducted surveys in O'Donnell Canyon in 1989, 1991, 1992 and 1993 to monitor reintroduction of Gila topminnow (Table 13). Gila chub was the only species recorded from a site on the Audubon Research Ranch in 1989. No fish were caught from a location called O'Donnell Tank in 1989 or 1991. In 1992, Gila chub (45 percent) and green sunfish (55 percent) were caught at a site on the Audubon Research Ranch. In 1993, longfin dace (65 percent), Gila chub (26 percent) and green sunfish (10 percent) were collected from the same location.

Table 13. Summary of fish collections from O'Donnell Canyon, Santa Cruz County, Arizona during annual Gila topminnow monitoring. Species code abbreviations are defmed in Appendix A.

Location	Date	relative abundance of fish collected (%), total n collected
T21S R18E S. 28 SW4 SE4	890726	GIIN (100%), n=5
O'Donnell Tank T21S R18E S. 28 SW4 SE4	890726, 910106	None
T21S R18E S. 28 SW4 SE4	920617	LECY (55%), GIIN (45%), n=55
T21S R18E S. 28 SW4	930811	AGCH (65%), GIIN (26%), LECY (9%), n=155

In 1991, biologists with TNC established four fixed monitoring stations in O'Donnell Canyon. They were monitored in 1991, 1992 and 1994. Gila chubs were collected all three years (Table 14).

Table 14. Relative abundance of fishes collected during TNC Monitoring of O'Donnell Canyon, Santa Cruz County, Arizona in 1991, 1992 and 1994.

Year	Gila chub	longfin dace	Sonora sucker	green sunfish
1991 (n=273)	52%	6%	6%	36%
1992 (n=20)	15%	10%	40%	35%
1994 (n=132)	36%	5%	8%	52%

Post Canyon was also surveyed in 1989, 1991 and 1992 by AGFD biologists. In 1989, seven largemouth bass and one Gila chub were collected below the dam. No fish were collected in 1991, and only largemouth bass were observed in 1992. The source of the largemouth bass is unknown, but they are likely the result of illegal stocking.

Recent Survey Results

A large cement headcut control structure is present on the Canelo Hills Preserve. Above this structure the cienega was heavily overgrown by riparian vegetation and could not be sampled. Below the structure, the channel is deeply incised and consists of deep pools with vertical and undercut banks separated by shallow riffles and falls. During surveys conducted in August 1995, Gila chub (55 percent) (n=6), green sunfish (27 percent) and Sonora sucker (18 percent) were collected on the Canelo Hills Cienega Preserve downstream of the cement headcut control structure and upstream of the Research Ranch boundary. The same areas surveyed in 1992 and 1993 during Gila topminnow monitoring were resurveyed in 1995, but contained only two Gila chub. This is likely due to a prolonged drought in the spring and early summer of 1995, which reportedly dried all of O'Donnell Canyon below the Canelo Hills Preserve boundary (Bill Brannon, NAS, pers. comm.). The two chub collected on the Research Ranch were likely early

dispersers from the Preserve when monsoons finally relieved the drought in late summer. A total of seven specimens were preserved and will be sent to ASU.

Trammel and gill nets were set in the Post Canyon impoundment in 1995, but no fish were collected. However, three largemouth bass were collected from pools below the dam. No Gila chub remain in Post Canyon.

Status, Threats and Management Recommendations

Stable-Threatened. Historical distribution and abundance data are insufficient to determine declines for Gila chub. Although Gila chubs are relatively abundant in O'Donnell Canyon, nonnative green sunfish poses a threat to their continued existence. Habitats managed on the Canelo Hills Cienega Preserve and the Audubon Research Ranch should remain protected from other habitat degradations. Based on surveys in 1995 and the description of conditions present prior to those surveys, it appears that perennial flow during drought years is present only on the Canelo Hills Preserve. Occupation of habitat downstream on the Audubon Research Ranch is dependant on local climatological factors that affect surface availability of water.

Based on studies conducted by Dudley (1995), green sunfish are most likely suppressing this Gila chub population's abundance and recruitment. Attempts should be made to remove green sunfish from O'Donnell Canyon and improve habitat conditions above the headcut control structure to allow introduction of Gila chub in habitat free of nonnatives.

Turkey Creek

Site Description

Turkey Creek, Santa Cruz County, Arizona, is a tributary of O'Donnell Canyon, which flows into the Babocomari River, a tributary of the San Pedro River. Turkey Creek flows north from the northeastern portion of the Canelo Hills and western Huachuca Mountains near an elevation of 1585 m (5200 ft) to the confluence with O'Donnell Canyon at an elevation of 1430 m (4700 ft).

Land Ownership

Land ownership within a 1.6 km (1.0 mi) buffer along Turkey Creek beginning at the confluence with O'Donnell Canyon and continuing upstream 15.7 km (9.8 mi) to State Highway 83 comprises USFS Coronado National Forest (52 percent), private (34 percent) and BLM (13 percent). A majority of the stream length within the delineated area, including holdings by the USFS and BLM, is managed under a cooperative agreement with the National Audubon Society's Research Ranch.

Land and Water Uses

Locations of known perennial water from Gori (1993) are found on the Turkey Creek Land Ownership Map. Cattle grazing does not occur on lands managed by the Audubon Research Ranch, including BLM and USFS lands within the Research Ranch boundaries. Cattle grazing

does occur on BLM and USFS land elsewhere in the watershed. Other land uses on private lands are unknown, but private property upstream of the USFS Administration site appeared to be heavily grazed and pastures were noted within the flood plain.

Collection History

Gila chubs were first collected from Turkey Creek in 1952, at Canelo by an unknown collector. A number of collections was made from 1977 through 1986 (Table C-25), and Gila chubs were abundant on private and USFS property (n=496 and 309, respectively) in September 1988 during FFC surveys. The last documented collection of Gila chub in Turkey Creek was July 1991, despite several surveys since. The only other fish species documented from Turkey Creek is longfm dace. Longfm dace was collected, along with the first collection of Gila chub, in 1952. Longfin dace also was collected in 1989 (n=1) and late 1991 (n=1).

Recent Survey Results

In 1995, no fish were found in Turkey Creek during surveys conducted with a backpack electroshocking unit on the private land downstream of the USFS Administration site and near the southern boundary of the Audubon Research Ranch. The only habitat available was isolated pools having no surface flow connecting them. The water in many of these pools appeared to be of poor quality, although parameters measured were within acceptable values (pH=7.4, conductivity=900, temperature=26 ° C, dissolved oxygen= 3.6 ppm). The landowner indicated he has not observed fish in Turkey Creek since 1991. Prior to 1991, he would regularly observe chub swimming in pools just downstream from his house.

Status, Threats and Management Recommendations

Extirpated (tentative). Gila chub appear to have been extirpated from Turkey Creek at some point between 1991 and 1992. Poor water quality or desiccation of the stream during this period may have played a role in their disappearance. A complete and thorough survey of all surface water in Turkey Creek should be conducted to verify extirpation of Gila chub. Any plans to reintroduce chub into Turkey Creek must address the issue of water quantity and quality.

Bonita Creek

Site Description

Bonita Creek is a tributary of the Gila River in Graham County, Arizona. It flows south and east between the Gila Mountains on the southwest, and the Nantac Rim to the northeast, and joins the Gila River east of Safford. Headwaters of Bonita Creek are at an elevation of 1580 m (5200 ft). Bonita Creek joins the Gila River at 960 m (3160 ft). The lower portion of Bonita Creek is within the BLM Gila Box Riparian National Conservation Area (RNCA).

Land Ownership

Approximately half of Bonita Creek is on the San Carlos Apache Indian Reservation. The lower half is predominantly federally owned by BLM. Ownership within a 1.6 km (1.0 mi) buffer zone

beginning at the Gila River and continuing upstream 96.1 km (59.7 mi) comprises Tribal (55 percent), BLM (41 percent), and private (3 percent) lands.

Land and Water Uses

Land and water uses on the Reservation and private land are unknown. BLM lands are subject to multiple uses as mandated by Congress and include: grazing, logging, mining and recreation uses, including ORV. Land along Bonita Creek within the BLM's Gila Box RNCA is not currently subject to any of the listed activities, however several mining claims are being reviewed (Mike McQueen, BLM, pers. comm.). The upper portion of Bonita Creek from the Reservation Boundary downstream to the "Narrows" is grazed only in winter. No riparian grazing should be occurring below this point (Mike McQueen, BLM, pers. comm.). BLM does maintain some low volume pumps to provide water for livestock outside the riparian area. The city of Safford takes water from Bonita Creek to supply municipal uses. They also have a maintenance right-of-way from the Gila River upstream to the intake structure.

In 1995 the city of Safford was considering options to increase their water rights and withdrawals from Bonita Creek (Jeff Simms, BLM, pers. comm.). BLM has a "reserved water right" from Congress for remaining surface flow, which may be in jeopardy if Safford secures increased water rights.

Collection History

The earliest reported collection of *Gila* in Bonita Creek was in 1950 by Miller and Winn near the confluence with the Gila River (Table C-26). These specimens are reported as *G. robusta* by the UMMZ. However, the specimens were never re-examined, and other collections from Bonita Creek have been identified as *G. intermedia* (DeMarais 1986). Gila chubs have been collected many times since 1950, and recent surveys by BLM fisheries biologists in 1992 and 1993 provide good data on distribution and abundance.

Jeff Simms (BLM) conducted an inventory of lower Bonita Creek (lowest 6.0 km [3.75 mi]) in June and July 1992. Results of these surveys were made available in a BLM Memorandum to the Gila Resource Area Manager. The following fish (n=25,865) were collected in 21,000 seconds of electroshocking: longfin dace (77.6 percent), Sonora sucker (12.1 percent), desert sucker (5.4 percent), speckled dace (3.1 percent), yellow bullhead (0.7 percent), fathead minnow (0.4 percent), Gila chub (0.2 percent), carp (0.1 percent), channel catfish (0.1 percent), and mosquitofish (0.01 percent). Gila chubs collected were usually solitary and heavily parasitized by *Lernaea.* Minckley and Sommerfeld (1979) found that lower portions of Bonita Creek suffered an oxygen deficit in summer, with concentrations below the 6.0 mg/l (less than 60 percent saturation) recommended for fish. They also reported that channel catfish occasionally invade the lower few kilometers of Bonita Creek. Simms noted that young chub were uncommon in this reach of Bonita Creek in 1992, even following their peak breeding season. He reported that mosquitofish were highly under-represented in the sampling due to electroshocking bias.

A fish salvage operation was conducted in March 1993 within 1.4 km (0.85 mi) of the lower 6.0 km (3.75 mi) of Bonita Creek. It produced 17,500 fish, of which only 67 were Gila chub. Many of the chubs had visible signs of skin infections.

Simms, in conjunction with AGFD personnel, conducted surveys in December 1993. The following species were collected from 14 separate pools (pools were the only habitat sampled) by electroshocking (1,948 seconds) or hoop-netting (1 pool): longfin dace (35 percent), desert sucker (28 percent), Sonora sucker (24 percent), Gila chub (9 percent), and speckled dace (4 percent) (total n=4904). The pools were distributed throughout 6.8 km (4.25 mi) of middle Bonita Creek from "the Narrows" upstream to where surface flow began near the Reservation boundary.

Simms provided information delineating reaches of Bonita Creek occupied by Gila chub based on his personal observations and collections. Those reaches have been transferred to the Bonita Creek Land Ownership Map and are highlighted in blue.

Recent Survey Results
Adequate data were available for Bonita Creek, therefore it was not sampled.

Status, Threats and Management Recommendations
Stable-Threatened. The lack of historical distribution and abundance data for Gila chub disallows establishing long term trends in population status. Fishes in the middle portion of Bonita Creek appear to be healthy and recruitment is evident. No nonnatives were collected above the Safford withdrawal in 1993 and they were relatively scarce between there and the Gila River confluence. In 1995, Jeff Simms (BLM, pers. comm.) indicated that Gila chubs occupied Bonita Creek from the Gila River confluence to approximately 6.4 km (4 mi) upstream where they were considered rare, and from 14 km (9 mi) upstream of the confluence to 23 km (14 mi) above the confluence. Gila chubs in the lower portion appear to be in poor condition and were suffering from increased incidence of parasitism by *Lernaea,* likely as the result of degraded habitat condition and/or decreased water flows due to water withdrawals.

The greatest threat to Gila chub in Bonita Creek is continuing, and potentially, increasing water withdrawals by the city of Safford. Efforts should be made to maintain or increase base flows throughout Bonita Creek. Distribution of Gila chubs upstream of the BLM-San Carlos Indian Reservation boundary is unknown.

Eagle Creek

Site Description
Eagle Creek, Graham and Greenlee counties, Arizona, is a tributary of the Gila River in eastern Arizona and flows southward from the Mogollon Rim. It drains lands on the San Carlos Apache Indian Reservation and the Apache-Sitgreaves National Forest. It is a second-order stream with headwaters originating in mixed-conifer forests near 2800 m (9190 ft) elevation and joining the

Gila River near 1000 m (3300 ft) elevation. Twenty one species of fish have been collected from Eagle Creek, which included ten native and 11 nonnative fishes (Marsh et al. 1990).

Marsh et al. (1990) described the stream as follows: headwater reaches of Eagle Creek have a gradient of 90 m/km, which moderates to 4 m/km when the stream flows about 20 km (12 mi) through a broad, grassy valley. The steam then flows about 64 km (40 mi) through deep steep-walled canyons with a gradient of 7.4 m/km to the Gila River. Flows in Eagle Creek are augmented by an interbasin transfer of water from the Black River pumped directly into Willow Creek, a tributary of Eagle Creek. Minckley and Sommerfeld (1979) computed that the average annual discharge of Eagle Creek for the period 1946 to 1969 had been augmented 27 percent by interbasin transfer of water from the Black River into Willow Creek.

Land Ownership

Eagle Creek is 105.5 km (65.6 mi) long from its confluence with the Gila River upstream to East Eagle Creek, above Honeymoon Campground. Land ownership within a 1.6 km (1.0 mi) buffer around this reach of stream comprises San Carlos Apache Indian Reservation (33 percent), Apache-Sitgreaves National Forest (31 percent), private lands (16 percent), BLM (14 percent), and State Trust Lands (7 percent).

Land and Water Uses

The watershed is currently affected by cattle grazing, logging and extensive open pit mining. Over the years, several diversion structures have been constructed, washed out by floods and rebuilt. Currently, a diversion dam nearing 5 m (16 ft) in height is present in lower Eagle Creek and water is pumped via an aqueduct by Phelps Dodge to mining operations near Morenci. Water is diverted or pumped out of the creek for the purposes of mining/ore processing and municipal/industrial uses.

Collection History

Ten native fishes are known from Eagle Creek including: an undetermined native trout, loach minnow, spikedace, longfin dace, speckled dace, Sonora sucker, desert sucker, razorback sucker (reintroduced), roundtail chub and Gila chub. Loach minnow was not collected from 1950 until 1995 (Paul Marsh, ASU CES, pers. comm.). Eleven nonnative fishes have been collected from Eagle Creek including: rainbow trout, carp, red shiner, fathead minnow, yellow bullhead, channel catfish, flathead catfish, mosquitofish, smallmouth bass, largemouth bass and black bullhead (Marsh et al. 1990).

Identification of *Gila* from Eagle Creek remains problematic. DeMarais (1995) recommended that specimens should be designated as *G. intermedia* or *G. robusta* only after careful evaluation of diagnostic characters. Therefore, unless specimens have been positively identified based on diagnostic characteristics provided by Rinne (1969), identification will remain suspect.

The earliest known collection of *Gila* was in 1934 by Madsen (Table C-27). Gorsuch also collected *Gila* in 1939. Miller collected *Gila* with longfin dace, speckled dace, loach minnow,

Sonora sucker and desert sucker in 1950. The *Gila* collected by Madsen are referred to as *G. robusta,* and the *Gila* collected by Gorsuch as an intergrade between *G. robusta* and *G. intermedia* by the UMMZ. Collections by Miller in 1950 included *G. robusta* and an intergrade form. Specimens collected by Clarkson in 1978 at Honeymoon campground are reported as *G. intennedia* by ASU Museum of Fishes. DeMarais (1986) examined Clarkson's three specimens as well as three other uncatalogued specimens and determined them to be *G. intennedia.* Marsh et al. (1990) reported that the problematic *G. intermedia*-like chub was the only native fish collected at Honeymoon Campground, and it was restricted to that site in 1987. DeMarais (1992) reported that those chub exhibited an allelic frequency between *G. robusta* and *G. intermedia*.

Kynard (1976) reported collecting roundtail chub from upper Eagle Creek near Honeymoon Campground, but no specimens were retained; therefore, identification can not be confirmed. Papoulias et al. (1989) summarized several historical collections (Madsen 1935; Mulch and Gamble 1956; Kynard 1976; Bestgen 1985; Propst et al. 1985) from the Eagle Creek drainage and referred to chub collected by Madsen in 1934 as *G. robusta.* They reported capturing longfin dace, Sonora sucker, speckled dace, fathead minnow, razorback sucker (reintroduced) and desert sucker during field studies.

In July 1993, nine of the 20 species known from Eagle Creek (rainbow trout, longfin dace, carp, roundtail chub, speckled dace, Sonora sucker, desert sucker, yellow bullhead and channel catfish) were captured following severe winter flooding (Paul Marsh 1993 summary memo). Capture of the *intermedia-like* form of chub reported from 1987 (Marsh et al. 1990) was not indicated.

AGFD personnel, in coordination with FWS biologists from the Pinetop FAO, conducted a fisheries survey in lower Eagle Creek in June 1995. Surveys began at the gauging station (T1S R28E, Sec. 32) and continued downstream about 24 km (15 mi). Sites were sampled approximately one mile apart beginning at the USGS gauge. *Gila* were captured (n=40), however none were preserved and morphometric measurements and meristic counts were not made in the field. Species identification is not possible, but *Gila* represented 3 percent of the fishes collected. Other species collected included speckled dace (43 percent), desert sucker (31 percent), Sonora sucker (13 percent), smallmouth bass (6 percent), longfm dace (4 percent), yellow bullhead (1 percent) and channel catfish (<1 percent) (total n=1596).

The Phelps Dodge diversion dam apparently acts as a barrier to upstream movement of fishes from the Gila River, as the fauna below the dam has a greater diversity of nonnatives. Periodic flooding appears to decrease the presence of nonnatives, subsequently decreasing the impacts to native fishes by nonnatives in Eagle Creek above that diversion dam (Marsh et al. 1990).

Recent Survey Results
Eagle Creek was not surveyed for this project.

Status, Threats and Management Recommendations
Unstable-Threatened. The identification and presence of *G. intermedia* in Eagle Creek remains problematic. Data from Marsh et **al.** (1990) indicate that fish most closely resembling *G. intermedia* were present at only one location, Honeymoon Campground. The rest of the stream was inhabited by *G. robusta.* DeMarais (1986) indicated that specimens from upper Eagle Creek (ASU Museum Catalog No. 7836 and uncatalogued specimens) were identified as *G. intermedia,* although their morphologies may reflect minor introgression of *G. robusta* characters. According to DeMarais (1992) ongoing hybridization with roundtail chub (possibly present as a result of an introduction) may be occurring in Eagle Creek, the only stream the two species are found together.

San Simon River

Site Description
The San Simon River is a Gila River tributary that originates in Hidalgo County, New Mexico, and flows through Cochise and Graham counties, Arizona. The river runs from an elevation of 1280 m (4200 ft) at the headwaters in New Mexico to an elevation of 905 m (2970 ft) at the Gila River confluence near Solomon, Arizona. The San Simon River passes about 145 km (90 mi) through the San Simon Valley (including Arizona and New Mexico) to the Gila River confluence. Historically the watershed was a broad grassland with scattered mesquites. A stream flowed through braided channels between marshy banks. It changed rapidly after about 1885 due to heavy grazing by large herds of cattle (Hendrickson and Minckley 1984).

Land Ownership
A Land Ownership Map was not produced for the San Simon River, but ownership is known to include mainly BLM, with some State and private holdings.

Land and Water Uses
Historically, the San Simon Valley was heavily grazed. San Simon Cienega was a well known watering location for pioneers, military and survey parties working in the region. San Simon Cienega, now artificially maintained by BLM, represents the only cienega remaining in the drainage (Hendrickson and Minckley 1984).

Collection History
Gila chub historically inhabited cienegas of the upper San Simon River (Minckley 1969; Rinne 1969). The UMMZ has specimens collected in 1939 by an unknown collector from San Simon Cienega, one mile north of Warner Ranch (Table C-28). They were identified as *G. robusta* x *G. intermedia* intergrades. However, Rinne (1969) identified those 17 specimens from UMMZ (collection #137093) as *G. intermedia.* Subsequent collection of Gila chub is unknown.

Recent Survey Results
The San Simon River was not surveyed for this project.

Status, Threats and Management Recommendations
Extirpated. Gila chub is considered extirpated from the San Simon River, Arizona.

San Francisco River Basin

Harden Cienega Creek and Dix Creek

Site Description
Harden Cienega Creek is a tributary of the San Francisco River, Greenlee County, Arizona and Grant County, New Mexico. Its headwaters are at an elevation of 1770 m (5800 ft) and it joins the San Francisco River at an elevation of 1220 m (4000 ft) in Arizona. Dix Creek is also a tributary of the San Francisco River about 3.2 km (2 mi) downstream of Harden Cienega Creek.

Surface water in Harden Cienega Creek is separated from the San Francisco River by nearly one mile of ephemeral stream. Dix Creek is dry at the confluence and a natural rockfall fish barrier is present about 1.6 km (1 mi) upstream from the confluence with the San Francisco River. These factors are believed to effectively isolate the streams from nonnative immigration. Perennial flow was found in only 3.2 km (2 mi) of the lower portion of Dix Creek above the confluence (Paul Marsh, ASU CES, pers. comm.).

Land Ownership
Land ownership along Harden Cienega Creek within a 1.6 km (1.0 mi) buffer beginning at the San Francisco River and extending upstream 16.5 km (10.25 mi) to the Arizona/New Mexico border comprises Apache-Sitgreaves National Forest lands (99 percent) and private land (1 percent). The private land is located at the confluence of Harden Cienega Creek with the San Francisco River (Harden Cienega Creek Land Ownership Map). A land exchange is currently being evaluated that may transfer that private property to the USFS (Bob Csargo, USFS, pers. comm.).

Land and Water Uses
Land managed by USFS is subject to multiple uses as mandated by Congress, and is currently grazed, although middle portions of Harden Cienega and Dix Creeks are within narrow canyons that are not accessible to cattle (Bob Csargo, USFS, pers. comm.). Other specific uses are not currently known.

Collection History
The only known museum record of Gila chub from Harden Cienega Creek was collected in 1988 by DeMarais (Table C-29). Anderson and Turner (1977) reported collecting ten *Gila* specimens, which they reported as "grahami." They preserved all ten specimens, however, these specimens are not in museums contacted for this status review. They are believed to be Gila chub. Montgomery (1985) surveyed Harden Cienega Creek and Dix Creek and reported *G. robusta* from Harden Cienega Creek, although they are now considered Gila chub based on identification of subsequent specimen collected by DeMarais (ASU 12171) . Personnel from ASU surveyed

Harden Cienega Creek and Dix Creek again in 1995 (Table 15) and reported *G. intermedia* from both streams, the first time *Gila* have been reported from Dix Creek.

Recent Survey Results
Harden Cienega Creek was not surveyed for this project.

Table 15. Summary of fish collections from Harden Cienega Creek and Dix Creek, Greenlee County, Arizona. Species code abbreviations are defined in Appendix A.

Source	Location and date	Fishes Collected (relative abundance)
Anderson and Turner (1977)	Harden Cienega Creek, lower 3 km, 1977. (Id. of GIIN not confirmed with specimens)	GIIN (48%), RHOS (24%), AGCH (14%), CAIN (10%), PACL (5%)
	Dix Creek	PACL (43%), RHOS (32%), AGCH (15%), CAIN (10%)
Montgomery (1985)	Harden Cienega Creek, 1.6 km above confluence, May and Dec. 1983 and June 1984. (reported as GIRO, Id. not confirmed with specimens)	RHOS (45%), PACL (29%), AGCH (17%), GIIN (8%), CAIN (1%)
	Dix Creek, about 2.4 km above confluence, July 1983 and June 1984	RHOS (38%), PACL (36%), CAIN (19%), AGCH (6%)
Paul Marsh (ASU CES, pers. comm.)	Harden Cienega Creek, Sep. 1995.	RHOS (43%), PACL (27%), GIIN (23%), AGCH (6%), CAIN (1%)
	Dix Creek, at FR 84 X-ing, below "The Hole" Aug. 1995.	RHOS (75%), AGCH (18%), GIIN (4%), PACL (2%), CAIN (1%)
	Dix Creek, 0.6 km above FR 84 X-ing, above "The Hole" Aug. 1995.	RHOS (75%), GIIN (25%)

Status, Threats and Management Recommendations
Unknown. No collections to date have reported nonnatives in Harden Cienega or Dix Creek. Lack of historical distribution and abundance data do not allow for determining the qualitative or quantitative declines of these populations. All past collections were made in the lower portions of both streams, and upstream distributional ranges are unknown, although suitable habitat may not be available. Additional surveys are highly recommended.

Summary and Conclusions

PRESENT DISTRIBUTION

Gila chub is currently limited to 23 isolated Gila River basin streams or cienegas in central and southern Arizona (Table 16, Fig. 2) and northern Sonora, Mexico. Bancroft et al. (1980) listed *G. intermedia* from Webber Creek. Original data sheets record *G. r. robusta* as the species caught (Rob Clarkson, BOR, pers. comm.), and Silvey et al. (1984) reported *G. r. robusta* as being present. Webber Creek is a tributary of the East Verde River, which contains the phenotypically intermediate roundtail chub (DeMarais 1986).

The species is considered extirpated in New Mexico, including the San Francisco, Gila, and San Simon River drainages (Bestgen and Propst 1989; Sublette et al. 1990). The current known distribution of Gila chub in Mexico is limited to the Cienega los Fresnos, adjacent to the Arroyo los Fresnos (tributary of the San Pedro River), within 2 km (1.2 mi) of the Arizona-Mexico boundary. Cienega los Fresnos lies in a natural grassland used for livestock grazing without adequate management. Other populations may persist in the upper San Pedro River and Santa Cruz River drainages, but comprehensive surveys have yet to be conducted.

Gila chub formerly occupied, but is (or may be) now extirpated from the following aquatic systems:

Cave Creek/Seven Springs
Sonoita Creek (Monkey Spring)
Santa Cruz River
Turkey Creek
Queen and Arnette Creeks
Garden Canyon (re-introduced)
Fish Creek
San Simon River (Arizona and New Mexico)
San Pedro River (Arizona only)
Williamson Valley and Big Chino Wash
Post Canyon (tributary to O'Donnell Canyon)

Gila chub currently inhabits the following aquatic systems:

T-4 Spring (Babocomari River)
Blue River
Cienega Creek
Eagle Creek
Indian Creek
Larry Canyon (stock from Silver Creek)
O'Donnell Canyon
Red Tank Draw
San Carlos River
Silver Creek
Sycamore Creek
Bass, Hot Springs and Double R canyons
Bonita Creek
Dix Creek
Harden Cienega Creek (Az.)
Little Sycamore Creek
Lousy Canyon (stock from Silver Creek)
Redfield Canyon
Sabino Canyon
Sheehy Spring
Spring Creek
Walker Creek
San Pedro River (Arroyo los Fresnos, Sonora, Mexico).

Table 16. Summary of current distribution and status of historically known Gila chub populations.

Location	Location Description	Present (last observed)	Population Status	Most recent collection/ Lit. Reference
Agua Fria River, Yavapai and Maricopa Counties	Gila River drainage, specimens seen by W.L. Minckley in 1966 from the Agua Fria River were reportedly Gila chub (Rinne 1969), but there are no museum collections to verify this.	No	Extirpated	AGFD and FFC monitoring
Babocomari River, Santa Cruz and Cochise Counties	San Pedro River drainage.	Yes, in T-4 Spring (1988)	Unstable-Threatened	AGFD 1988 monitoring (OFC462, OFC463)
Bass Canyon, Graham and Cochise Counties	San Pedro River drainage, includes Hot Springs and Double R canyons.	Yes (1994)	Stable-Threatened	TNC 1991-1994 monitoring
Big Chino Wash, Yavapai County	Verde River drainage, tributary above series of falls now partially inundated by Sullivan Lake.	No (1950)	Extirpated (tentative)	Rinne (1976)
Binghampton Pond, 3 mi N of Tucson	Santa Cruz River drainage.	No (1943)	Extirpated	UMMZ collection # 146648
Blue River, Gila County	Gila River drainage, tributary to San Carlos River.	Yes (1995)	Unknown	FWS Pinetop FAO (pers. comm.)
Bonita Creek, Graham County	Gila River drainage and tributary.	Yes (1993)	Stable-Threatened	Civish (1994)
Cave Creek/Seven Springs Wash, Maricopa County	Salt River drainage.	No (1978)	Extirpated	Young and Bettaso (1994)
Cienega Creek, Pima and Santa Cruz Counties	Santa Cruz River tributary.	Yes (1993)	Stable-Secure	AGFD topminnow monitoring (1995)
Dix Creek, Greenlee County	San Francisco River tributary.	Yes (1995)	Unknown	P. Marsh, ASU (pers. comm.)
Eagle Creek, Graham and Greenlee Counties	Gila River tributary	Yes (1978)	Unstable-Threatened	ASU #7836

Table 16. Continued.

Location	Location Description	Present (last observed)	Population Status	Most recent collection/ Lit. Reference
Fish Creek, Maricopa County	Salt River drainage.	No (1965)	Extirpated	AGFD 1993 monitoring
Garden Canyon, Cochise County	San Pedro River drainage, stocked by AGFD from Turkey Creek (n=150).	No (1988)	Extirpated	AGFD 1995 monitoring
Harden Cienega Creek, Greenlee County	San Francisco River tributary.	Yes (1995)	Unknown	P. Marsh, ASU (pers. comm.)
Indian Creek, Yavapai County	Agua Fria River drainage (Langhorst 1995).	Yes (1995)	Unstable-Threatened	Langhorst (1995)
Larry Creek, Yavapai County	Agua Fria River drainage, stocked by BLM in 1995 from Silver Creek.	Yes (1995)	Unknown	Langhorst (1995)
Little Sycamore Creek, Yavapai County	Agua Fria River drainage.	Yes (1995)	Unstable-Threatened	AGFD 1995 monitoring
Lousy Canyon, Yavapai County	Agua Fria River drainage, stocked by AGFD/BLM in 1995 from Silver Creek.	Yes (1995)	Unknown	Langhorst (1995)
Monkey Spring/Sonoita Creek, Santa Cruz County	Santa Cruz River drainage, extirpated by largemouth bass introduction (Minckley 1973).	No (1968)	Extirpated	DeMarais (1986), Minckley (1973)
O'Donnell Creek, Santa Cruz County	San Pedro River drainage.	Yes (1995)	Stable-Threatened	AGFD 1995 monitoring
Post Canyon, Santa Cruz County	Upper San Pedro River drainage. Tributary to O'Donnell Creek.	No (1989)	Extirpated	AGFD 1995 monitoring
Queen and Arnette Creek, Pinal County	Gila River drainage, possibly introduced from Salt River (see discussion).	No (1938,1945)	Extirpated	
Redfield Canyon, Graham and Pima Counties	San Pedro River drainage.	Yes (1994)	Stable-Threatened	TNC 1991-1994 monitoring
Red Tank Draw, Yavapai County	Verde River Drainage	Yes (1995)	Unknown	AGFD 1995 surveys

Table 16. Continued.

Location	Location Description	Present (last observed)	Population Status	Most recent collection/ Lit. Reference
Sabino Canyon, Pima County	Santa Cruz River drainage.	Yes (1994)	Unstable-Threatened	Dudley (1995)
San Carlos River, Gila and Graham Counties	Gila River drainage.	Yes (1995)	Unknown	S. Jacks (FWS, pers. comm.)
San Pedro River, U.S	Gila River drainage.	No (1912)	Extirpated	AGFD 1994 surveys
San Pedro River headwaters, Mexico	Gila River drainage, Sonora, Mexico	Yes (1995)	Unstable-Threatened	F. Abarca (AGFD, pers. comm.)
San Simon River, Cochise County	Gila River drainage, San Simon Cienega.	No (1939)	Extirpated	Rinne (1969), UMMZ 137093
Santa Cruz River, Santa Cruz and Pima Counties	Gila River drainage.	No (1904)	Extirpated (tentative)	Smithsonian Museum of Natural History
Sheehy Spring, Santa Cruz County	Santa Cruz River drainage.	Yes (1995)	Unstable-Threatened	AGFD Monitoring 1995
Silver Creek, Yavapai County	Agua Fria River drainage.	Yes (1995)	Stable-Threatened	Langhorst (1995)
Spring Creek, Yavapai County	Verde River drainage.	Yes (1995)	Stable-Threatened	AGFD 1995 monitoring
Sycamore Creek, Yavapai County	Agua Fria River drainage.	Yes (1995)	Stable-Threatened	Bettaso et al. (1995)
Turkey Creek, Santa Cruz County	San Pedro River drainage.	No (1991)	Extirpated (tentative)	AGFD 1995 monitoring
Walker Creek, Yavapai County	Verde River drainage.	Yes (1994)	Stable-Threatened	AGFD 1994 monitoring
Williamson Valley Wash, Yavapai County	Verde River drainage.	No (1992)	Extirpated (tentative)	T. Liles (AGFD, pers. comm.)

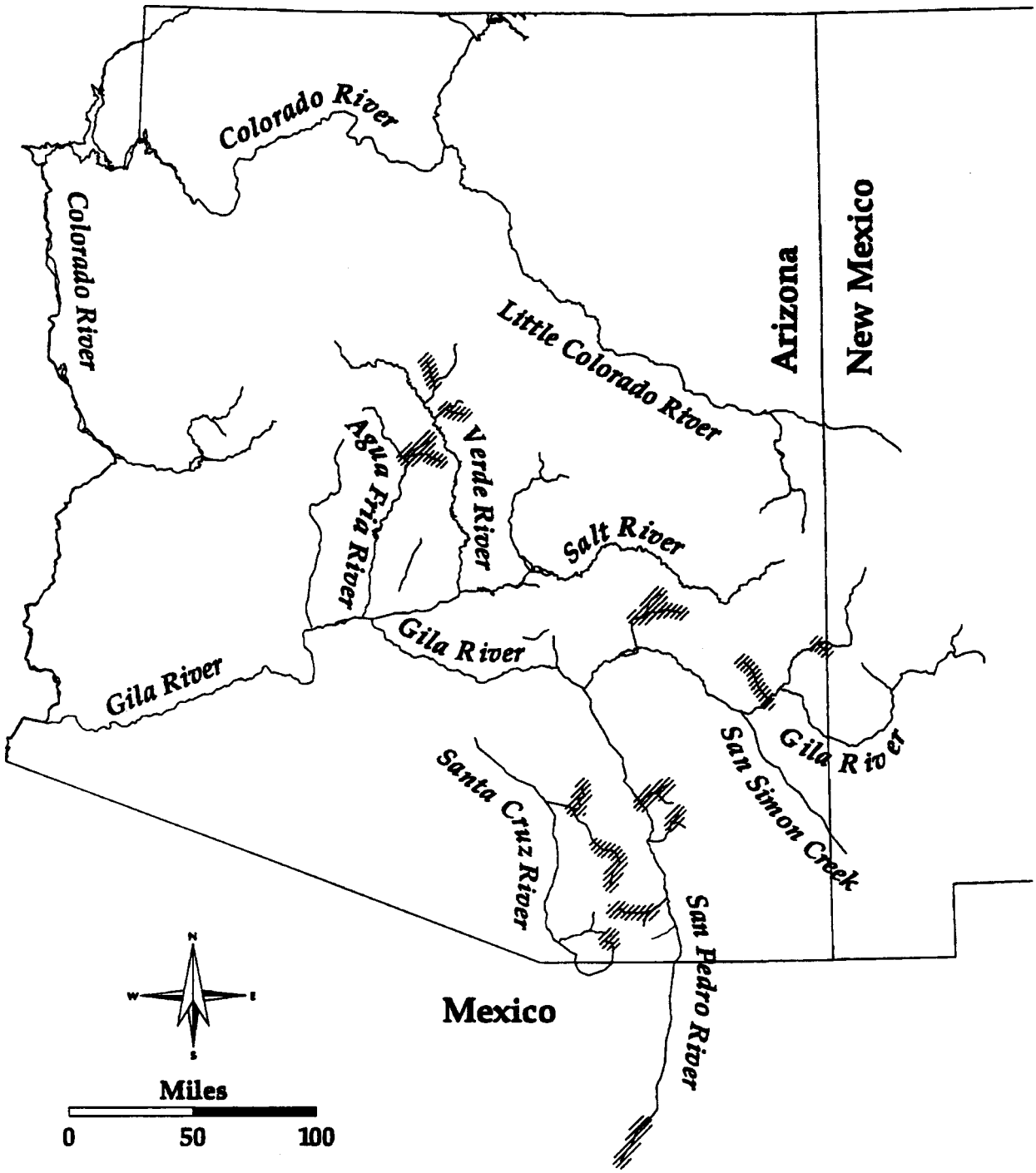

Figure 2. Present known distribution of Gila chub.

GAPS IN KNOWLEDGE

Estimates of population density are available only for Redfield Canyon (Griffith and Tiersch 1989) and Sabino Canyon (Dudley 1995). Range of distribution within those streams is unknown. Data on population sizes are lacking for all populations.

General life history research is needed. Vives (1990) identified areas to address, which included: determination of habitat use and requirements of Gila chub at all life stages; determination of range of natural variation in absolute and relative abundances of Gila chub and community members; studies of dietary preferences of larvae, juvenile and adult chubs; identification of the impacts resulting from direct and indirect interactions with nonnative fishes; quantification of the effects of physical habitat modification on life cycle completion; identification of the movement patterns of adults and larva (data will be used to assess the impacts of stream barriers on population movement); and continuation of taxonomic and systematic studies to determine relationships of Gila chub populations to each other and to other *Gila* species populations.

Gila chubs were discovered from two new streams in 1995, Red Tank Draw and Indian Creek. Identification of chubs collected from Red Tank Draw remains suspect, however. To date only four specimens have been preserved for identification, but dorsal-fin ray counts and ratio of head length to caudal peduncle depth indicate they are Gila chub. Identification will be confirmed by taxonomists at the ASU Museum of Zoology following submission of the specimens. Gila chubs were collected from one location in Indian Creek in 1995. Further surveys should be conducted to determine the areal distribution of Gila chub within this stream. It is likely that additional populations of Gila chub occur within its historic range that remain undiscovered.

Intensive surveys beyond the scope of funding for this project are needed to accurately document Gila chub distribution and abundance. Stream-specific range of Gila chub distribution is currently known only for Bonita Creek outside of the San Carlos Apache Indian Reservation and Cienega Creek. Qualitative and quantitative abundance of Gila chub within most streams is basically undocumented. The extirpation of Gila chub from Turkey Creek, Williamson Valley Wash, Big Chino Wash, Babocomari River, downstream of Babocomari Ranch, San Pedro River in the U.S. and the mainstem of the Santa Cruz River needs to be confirmed by intensive stream-wide inventories.

CURRENT AND FUTURE THREATS

Several Gila chub populations apppear to be declining (Sabino Canyon and Bonita Creek), although available data are insufficient to verify that trend. One population has recently disappeared (Turkey Creek in 1992). Principal causes of range-wide loss and decline of populations of Gila chub include loss of habitat due to water diversion and ground water pumping for irrigation and municipal uses, dam and reservoir construction, increased peak flood discharges and sedimentation resulting from land management practices and negative interactions with competitive and predatory nonnative fishes, especially green sunfish. Present distribution and abundance are also reflections of surface water declines contributed by lowering of water

tables and draining of marshes and cienegas by arroyo cutting (Hastings 1959; Miller 1961; Hastings and Turner 1965; Minckley and Deacon 1968; Rinne 1976; Hendrickson and Minckley 1984).

As of June 1995, the city of Safford, Arizona was considering petitioning the Arizona State Department of Water Resources for additional water extraction rights to Bonita Creek. This could directly affect the existing Gila chub population. Bureau of Land Management currently has a "reserved water right" from Congress for unallocated water in Bonita Creek (Jeff Simms, BLM, pers. comm.). The future of instream flows in Bonita Creek is threatened, at best.

The introduction of predatory and competitive nonnative fishes such as red shiner, fathead minnow, channel catfish, flathead catfish, mosquitofish, green sunfish, largemouth bass and smallmouth bass also pose a threat to Gila chub survival (Hubbs 1955; Miller 1961; Minckley and Deacon 1968; Rinne and Minckley 1970; Naiman and Soltz 1981; Meffe 1985; Williams and Sada 1985; AGFD 1988; Minckley 1991; Dunsmoor 1993; Ruppert et al. 1993). Dudley (1995) correlated green sunfish presence with Gila chub declines in Sabino Creek, Arizona. This included predation by small green sunfish on young-of-year Gila chub. Minckley et al. (1977) suggested that predation by green sunfish may explain the absence of Gila chub from the upper Santa Cruz River. Additionally, parasites introduced incidentally with nonnative species may jeopardize Gila chub populations (USFWS 1983). Gila chub in the lower portion of Bonita Creek, Arizona, appear to be adversely affected by *Lernaea* spp. (Civish 1994).

Natural environmental or climatological factors also may be impacting Gila chub populations. Seasonal fluctuations in the extent of available surface flow, associated stagnation effects of drying streams and increasing water temperatures may negatively affect Gila chub populations (Stout et al. 1970; Rinne 1975; Carpenter 1992; Dudley 1995), especially when combined with anthropogenic impacts and the current restricted distribution of the species. Documentation of such events can be correlated to changes in western cyprinid populations (Miller 1963; Minckley and Carufel 1967).

SPECIES STATUS

Twenty three separate and discrete populations of Gila chub currently exist. Of these, seven are of unknown status (two were recently established and survival is still uncertain), seven are considered unstable and threatened, eight are considered stable but threatened and one is considered stable and secure. Many of the factors contributing to the number of threatened populations are the result of human-induced factors, including the introduction of nonnative fishes and limited habitat due to human use or manipulation of water resources.

Additional survey work needs to occur in all known Gila chub habitat before population specific distributions and abundances can be determined. Historical range is poorly documented, but based on records and conservative inference, Gila chub formerly occupied as many as 30 different rivers, streams or spring systems. Several populations may have had basin-wide

distributions (i.e. Babocomari River basin and Santa Cruz River basin). Currently, Gila chub populations are effectively isolated by ephemeral reaches of stream or in-channel structures that impede movement and harbor predatory nonnatives.

Changes in climatological factors resulting in increasing aridity in the Southwest in conjunction with high levels of grazing may have resulted in the fragmentation of some formerly connected streams. As early as the turn of the century, Chamberlain (1904) identified cattle grazing, erosion, irrigation and mining as causes of general water quality problems resulting in the extinction of southwest fishes.

Direct impacts resulting from management actions likely resulted in the extirpation of one population, Cave Creek/Seven Springs. Introduction of nonnative fishes also has resulted in the extirpation of another population (Monkey Spring) and is likely depressing the abundance of others (Sabino Canyon, Sheehy Spring, O'Donnell Canyon).

MANAGEMENT RECOMMENDATIONS

The existing range of variation among *Gila* species should be protected, regardless of their ultimate evolutionary origin or taxonomic status, to preserve genetic diversity and species adaptation capabilities (Ryder 1986; Jones et al. 1988; DeMarais 1992). All existing Gila chub populations must be identified, protected and monitored for recruitment using standardized techniques, preferably biannually in the spring breeding season and in late autumn. (Vives 1990). Reduction of land erosion, preservation and protection of habitat, and stream improvement structures on some sites to create and/or maintain cienegas and pools could benefit Gila chub populations. Habitats critical to their survival include: cienegas, headwaters, spring-fed streams (Vives 1990) and spring-fed ponds free of nonnative fishes (Minckley 1969).

Further management needs include: maintenance of perennial flows with natural or simulated variation in flow regime, determination and implementation of potential habitat and landscape improvements such as removal of non-native fishes (e.g. see Dudley [1995] green sunfish removal from Sabino Creek), reintroduction of populations to selected streams within historic range, and closure of potential immigration routes to preclude reinvasion of nonnative fishes (Vives 1990). Careful consideration prior to release of nonnative fishes is also vital to preserving Gila chub and native fishes in general. The potential evolutionary importance of gene flow among *Gila intermedia, G. robusta* and phenotypically intermediate populations argues strongly for protecting the entire *Gila* complex of fishes (DeMarais 1992; DeMarais et al. 1992; Dowling and DeMarais 1993; DeMarais 1995).

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Appendix A. List of Abbreviations

Agency and program/project abbreviations:

Arizona Game and Fish Department	AGFD
Arizona State Land Department	ASLD
Arizona State University Museum of Zoology, Collection of Fishes	ASU
U.S. Department of the Interior, Bureau of Land Management	BLM
U.S. Department of the Interior, Bureau of Reclamation	BOR
U.S. Fish and Wildlife Service, Fisheries Assistance Office	FAO
AGFD, Native Fish Program, Fall Fish Count Project	FFC
Off Road Vehicles	ORV
National Audubon Society	NAS
AGFD, Native Fish Program, Native Fish Database	NFDB
BLM Riparian National Conservation Area	RNCA
Smithsonian Museum of Natural History	SMNH
The Nature Concervancy	TNC
University of Michigan, Museum of Zoology	UMMZ
U.S. Department of the Interior, Fish and Wildlife Service	FWS
U.S. Department of Agriculture, Forest Service	USFS

Abbreviations for Fishes (based on the first two letters of Genus and Species epithets):

Common Name	**Code**	**Common Name**	**Code**
longfin dace	AGCH	channel catfish	ICPU
yellow bullhead	AMNA	green sunfish	LECY
black bullhead	AMME	bluegill	LEMA
goldfish	CAAU	spikedace	MEFU
Sonora sucker	CAIN	smallmouth bass	MIDO
flannelmouth sucker	CALA	largemouth bass	MISA
red shiner	CYLU	rainbow trout	ONMY
desert pupfish	CYMA	desert sucker	PACL
Monkey Spring pupfish	CYSP	fathead minnow	**PIPR**
common carp	CYCA	Gila topminnow	**POOC**
mosquitofish	GAAF	Colorado squawfish	**PTLU**
Gila chub	GIIN	flathead catfish	**PYOL**
Rio Grande chub	GIPA	loach minnow	**TICO**
roundtail chub	GIRO	razorback sucker	**XYTE**
GilaXroundtail chub intergrade	GIROIN		

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Appendix C. Stream-specific summary of Gila chub collections. Reference identification numbers indicate museum records and field collections that are referenced on the Land Ownership Maps. Reference identification letters refer to museum records and field collections that are not referenced on the Land Ownership Maps. Species code abbreviations were defined in Appendix A.

Table C-1. Indian Creek, Yavapai County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
49.	**950516**	**AGFD NFDB FFC FC0170**	**Langhorst**	Indian Creek	**11N 3E** Sec. **25 SW4 SE4**	**341747 1115943**	**AGCH PACL**

Table C-2. Silver Creek, Yavapai County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	**800710**	**ASU 10251**	**Silvey**		**10N 3E** Sec. **10**		
B.	**800709**	**ASU 10288**	**AGFD**		**10N 3E** Sec. **10**		
C.	**800709**	**ASU 10291-10292**	**AGFD**		**10N 3E** Sec. **9**		
71	**920908**	**AGFD NFDB RHBOO1**	**Bettaso, Weedman**		**10N 4E** Sec. **7 SE4 & SW4**	**341523, 1115823**	None
74	**921008**	**AGFD NFDB FFC FC0160**	Hughes, **Langhorst**	Road crossing **N** of Bloody Basin **/Double** Tank Rd.	**10N 3E** Sec. **11 SE4**	**341529, 1120027**	**AGCH PIPR LECY PACL**
72	**931013**	**AGFD NFDB FFC FC0160**	Hughes, **Langhorst**		**10N 3E** Sec. **11 SE4**	**341529, 1120027**	**AGCH PIPR PACL LECY**
73	**941027**	**AGFD NFDB FFC FC0160**	Hughes, **Langhorst**		**10N 3E** Sec. **11 SE4**	**341529, 1120027**	None reported
88.	**941104**	**AGFD NFDB FFC FC0160**	Hughes **Langhorst**		**10N 3E** Sec. **9 SE4**	**341512, 1120222**	**AGCH PIPR PACL LECY**

Table C-3. Sycamore Creek, Yavapai County, Arizona.

Reference Id.	Date	Source		Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	300531	UMMZ 162837 listed as GIRO		Miller Winn	2 mi SE of Dugas			PACL RHOS
B.	680713	ASU 4434	Listed by ASU as GIRO	Ellis	Sycamore Creek, Station 5			
C.	680821	ASU 4435		Ellis	Sycamore Creek, Station 6			
D.	700218	ASU 4885		AGFD	Sycamore Canyon			CAIN PACL AMNA
84.	791026	ASU 8171		Clarkson	at Forest Service Admin. site			PACL AGCH RHOS at all sites
E.	800722	ASU 10296		AGFD	Sycamore Creek, Station 2	11N 3E Sec. 10		
F.	800722	ASU 12074	Listed by ASU as GIRO	Silvey	Sycamore Creek, Station 1	11N 3E Sec. 9		
G.	800723	ASU 12069		Silvey	Sycamore Creek Station 4	11N 4E Sec. 6		
H.	800903	ASU 12089		Nowakowski	Sycamore Creek, Station 5	11N 4E Sec. 7		
75	950413	AGFD NFDB DBD001		Dorum	0.75 mi below Double T Ranch	11N 5E Sec. 19 NW4 SW4	341857 1115223	ONMY
76	950413	AGFD NFDB DBD003		Dorum	Middle Box barrier	11N 4E Sec. 23 NE4 SE4	341902 115401	ONMY
77	950413	AGFD NFDB DBD002		Dorum	South Prong confluence	11N 4E Sec. 24 SE4	341843 1115307	ONMY

Table C-4. Little Sycamore Creek, Yavapai County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	800821	ASU 10007	Dahlberg	Little Sycamore Creek, Sta. 1	11N 4.5E Sec. 6		PACL AGCH RHOS
B.	800821	ASU 12082	Nowakowski	Little Sycamore Creek, Sta. 2	11N 4E Sec. 5		PACL AGCH RHOS
50.	950427	AGFD NFDB DBD001	Dorum	Little Sycamore Creek, above Homer Mountain Ranch	11N 4E Sec. 4 SE4 NE4	342145 1115613	AGCH PACL
51.	950427	AGFD NFDB DBD001	Dorum	Little Sycamore Creek, Reno Canyon Confluence	11N 4E Sec. 5 NW4 SE4	342142 1115725	AGCH PACL

Table C-5. Cave Creek and Seven Springs Wash, Maricopa County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	500601	UMMZ 162839 listed as GIRO	Miller, Winn	Cave Creek, 4 mi N of town of Cave Creek			RHOS
B.	500601	UMMZ 162841 listed as GIRO	Miller, Winn	Seven Springs, @ USFS campground, 20 mi NNE of town of Cave Creek			RHOS
C.	650907	ASU 2162-2164 listed as GIRO	Johnson	Cave Creek at 7 Springs picnic area			
D.	690000	ASU 4453	Stout	at Seven Springs			RHOS AGCH
E.	700318	ASU 4923, ASU 4929	Rinker, Anderson	Seven Springs, upper section, in ditch @ head spring			AGCH RHOS
F.	780222	ASU 7764	Clarkson	Cave Creek, at campground			

Table C-6. Fish Creek, Maricopa County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Other Species
A.	631007	ASU 474 listed as GIRO	Minckley	Fish Creek NE Tortilla Flat	
B.	651007	ASU 2246 listed as GIRO	Minckley	Fish Creek- NE Tortilla Flat	

Table C-7. Rye Creek, Gila County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Other Species
A.	791014	ASU 8144	Clarkson	2720' elevation	AGCH CAIN PACL PIPR CYLU

Table C-8. Walker Creek, Yavapai County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Other Species
89.	780908	ASU 8560	Rinne	Walker Creek	T15N R6E Sec. 35 SW4	
90.	940614	AGFD NFDB JLS001	AGFD	Walker Creek	T15N R6E Sec. 34 SE4 SW4	PACL RHOS
91.	940616	AGFD NFDB JTR001	AGFD	Walker Creek	T15N R6E Sec. 35 NE4 SE4	PACL RHOS
92.	940616	AGFD NFDB JTR002	AGFD	Walker Creek	T14N R6E Sec. 1 SE4 SE4	PACL RHOS

Table C-9. Oak Creek, Yavapai and Coconino counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township, Range	Other Species
A.	360312	UMMZ 113523, listed as GIRO approaching GIROIN	Gee	Lower Oak Creek at Sedona Ranger Station	17N 6E	AMME

Table C-10. Spring Creek, Yavapai County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Other Species
A	830606	ASU 10374-10378	DeMarais	N/A		
B	830616	ASU 10384-10387	DeMarais	N/A		
82.	790825	AGFD	Clarkson Grayson	at 3560' elevation	N/A	PACL RHOS MIDO CAIN AGCH
83.	850612	ASU 10458	DeMarais	N/A	16N 4E Sec. 22	
	940802	AGFD NFDB JTR001	AGFD Region 2	downstream from Forest Road 796	18N 4E Sec. 22	PACL RHOS CAIN
	950906	AGFD NFDB DAW001	Weedman	downstream from Forest Road 796	18N 4E Sec. 22	AGCH CAIN PACL PIPR RHOS

Table C-11. Williamson Valley Wash and Big Chino Wash, Yavapai County, Arizona.

Date	Source	Collector	Descriptive Location	Township Range	Other Species
(18)970313	SMNH 48121, reported as GIROIN	Gilbert	Chino, Arizona (Big Chino Wash)		MEFU RHOS TICO
500530	UMMZ 162834	Not available	Big Chino Wash, ca. 2 mi SE of K4 farm	19N 4W Sec. 23 NE4	CAIN
920516 920517	AGFD NFDB RHBOO1	Bettaso Anderson	Williamson Valley Wash	T17N R3W Sec. 30 NW4	

Table C-12. Queen and Arnette creeks, Pinal County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location
A.	No date	UMMZ 131823	Not available	Boyce Thompson Arboretum
B.	380905	UMMZ 125041 listed as GIRO	Hubbs et al.	"Green" (Queen) Creek, Boyce Thompson SW Arboretum, N Of Picketpost Mtn. ca. 4 mi W of Superior
C.	450815	SMNH 132268 listed as GIROIN	Bogert, C.M.	Arnette Canyon, 1 mi above dry wash of Queen Creek

Table C-13. San Carlos River, Gila and Graham counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Other Species
A.	680326	ASU 4644	Minckley	Warm Springs, N side of river, 10 mi NE of San Carlos	PACL LECY
B.	830517	ASU 10419-10421	DeMarais	San Carlos River	

Table C-14. Blue River, Gila County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	500512	UMMZ 162757	Miller, Winn	30 mi NE of Globe			PACL
B.	680419	ASU 4444 MSB 3414	Anderson	7 mi E of Cassodore spring			
D.	740613	ASU 6746, 11310	Kobetich	1 mile above crossing above falls			
E.	830516	ASU 11199	Marsh				
F.	830516	ASU 10485	Minckley				
G.	850523	ASU 11615	Minckley, Parkin	at Blue River Camp	2N 17E Sec.17		
12.	721202	ASU 6226	McNatt	crossing with Indian Route 5			
	880921	AGFD NFDB DAH002	Hendrickson	crossing with Indian Road #5	2N 20E	333037 •1101646	PACL

Table C-15. Santa Cruz River, Santa Cruz County, Arizona.

Date	Source	Collector	Descriptive Location	Other Species
(18)910419	SMNH 44092, reported as GIROIN	Jouy	Santa Cruz River, small tributary near Tucson	
(18)910419	SMNH 44088, 44089, reported as GIROIN	Jouy	Santa Cruz River, small tributary near Tucson	
(18)910505	SMNH 44090, reported as GIROIN	Jouy	Santa Cruz River, small tributary near Tucson	
(18)910518	SMNH 44094, reported as GIROIN	Jouy	Santa Cruz River	
(18)931120	SMNH 45440, reported as GIROIN	Mearns	Santa Cruz River, near Tucson	
040318	SMNH 129993, reported as GIROIN	Chamberlain	Santa Cruz River, Tucson	AGCH POOC
040325	SMNH 129990, reported as GIROIN	Chamberlain	Santa Cruz River, Tucson	AGCH POOC
040329	SMNH 129487, reported as GIROIN	Chamberlain	Santa Cruz River, San Xavier	PACL CAIN AGCH POOC
770400	ASU 7143	Minckley	unknown	

Table C-16. Cienega Creek, Pima and Santa Cruz counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	690000	UA 69-79-1		10 mi N of Sonoita	17E 19S		
B.	740427	ASU 6279	Minckley	at Cienega Ranch			
C.	740518	ASU 6747	Minckley	at Cienega Ranch			
D.	740628	ASU 6859	Minckley	at Cienega Ranch			

Table C-16. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
E.	760604	ASU 6860-6861	Kepner Landye	at Cienega Ranch			
F.	820317	UMMZ 209808	Belfit Meffe	confluence with Stevenson's Creek elevation 4200'	18S 17E sec. 23 NW4		
G.	830606	ASU 11519, ASU 11959	Meffe	at Ranch			
H.	830606	ASU 10364-10373	DeMarais				
27.	850731	AGFD. NFDB JEB002	Brooks			314930 1103410	AGCH POOC
28.	890724	AGFD NFDB BEB002	Bagley		18S 17E Sec. 35, NW4 NW4	314950 1103508	None
29.	890724	AGFD NFDB BEB004	Bagley		19S 17E Sec. 10, SE4 SE4	314730 1103515	AGCH POOC
30.	920618	AGFD NFDB DAW001	Weedman		19S 17E Sec. 10, NE4	315325 1103247	AGCH POOC
31.	921027	AGFD NFDB FFC FC0315	Not recorded		18S 17E Sec. 12 NE4 SE4 NE4	315230 1103345	AGCH POOC
32.	921031	AGFD NFDB FFC FC0313	BLM	Between Oak Tree Canyon and Empire Gulch	19S 17E Sec. 3, NE4 SE4	314833 1103522	AGCH POOC
33.	891021	AGFD NFDB FFC OFC031	BLM	Confluence of Cienega Creek and Mattie Canyon	18S 17E Sec. 23, NE4 NE4 SW4	315106 1103435	AGCH POOC
34.	921110	AGFD NFDB FFC FC0314	BLM	Downstream from Pump Canyon	18S 17E Sec. 13, SE4 NE4 NW4	315230 1103344	AGCH POOC
35.	931014	AGFD NFDB FFC FC0310	BLM	at confluence with Mattie Canyon	18S 17E Sec. 23, SW4 NE4	315110 1103430	AGCH POOC
36.	931014	AGFD NFDB FFC FC0309	BLM	at Mattie Canyon headwaters	18S 17E Sec. 23, SW4 NE4 SE4	315106 1103425	AGCH

Table C-16. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
37.	901121	AGFD NFDB FFC FC0312	BLM	between Gardner and Spring Water canyons	19S 17E Sec. 10, NE4	314812 1103513	AGCH POOC
38.	931028	AGFD NFDB FFC FC0316	BLM	between headwaters and Gardner Canyon	19S 17E Sec. 15, NE4 NE4 NE4	314713 1103515	AGCH POOC
39.	931015	AGFD NFDB FFC FC0315	BLM	between Pump and Fresno Canyon at flow station CC-1	18S 17E Sec. 12, NW4 NE4 SE4	315258 1103321	AGCH
40.	921028	AGFD NFDB FFC FC0311	BLM	in headwaters	19S 17E Sec. 15, SE4 SE4	314638 1103525	POOC
41.	931012	AGFD NFDB FFC FC0311	BLM	in headwaters	19S 17E Sec. 15, SE4 SE4	314638 1103525	POOC
42.	880818	AGFD NFDB	Bagley	near Sanford Canyon	18S 17E Sec. 23, NE4 NE4	315136 1103423	AGCH POOC

Table C-17. Sabino Canyon, Pima County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	1966	UA 66418-1	Not available	Lower Sabino Creek			
B.	290422	SMNH 94272	Kranzther				
C.	380906	UMMZ 125043 listed as GIRO	Hubbs et al.	16 mi NE. of Tucson, above picnic grounds			AGCH
D.	430418	UMMZ 146651	Simon	15 mi NE. of Tucson			GAAF POOC
E.	430619	UMMZ 146688	Simon	0.5 mi above end of road			
F.	490926	UA (Lowe's)	Not available				
G.	801022	ASU 8450	Hendrickson Minckley				

Table C-17. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
69.	901029	AGFD NFDB FFC FC0370	Not available	Sabino Canyon Recreation Area Between Bridges 8 & 9		322000 1104722	
67.	921109	AGFD NFDB FFC FC0350	Weedman	Sabino Canyon Recreation Area	13S 15E Sec. 9 NE4 NE4	321834 1104838	GAAF LECY
68.	930603	AGFD NFDB FFC BPD001	Denova	Sabino Canyon Recreation Area	13S 15E Sec. 9 NE4 NE4	322000 1104722	LECY
80.	940111	AGFD NFDB FFC FC0350	Lopez, Weedman	Sabino Canyon Recreation Area	13S 15E Sec. 9 NE4 NE4	321834 1104838	LECY
81.	941018	AGFD NFDB FFC FC0350	Lopez	Sabino Canyon Recreation Area	13S 15E Sec. 9 NE4 NE4	321834 1104838	LECY

Table C-18. Monkey Spring, Sonoita Creek, Santa Cruz County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Other Species
A.	040422	SMNH 130001, reported as GIRO	Chamberlain	Monkey Spring, Patagonia	CYMA POOC
B.	380907	UMMZ 125048, reported as GIRO	Hubbs et al.	Monkey Spring, 7 mi NE of Patagonia	
C.	500427	UMMZ 162699, reported as GIRO	Miller et al.	Reservoir fed by Monkey Spring	CYSP
D.	640131	ASU 597	Minckley	Sonoita Creek, Monkey Spring	
E.	640503	ASU 728	Minckley	Sonoita Creek, Monkey Spring	
F.	660317	ASU 2402	Barber	Sonoita Creek, Monkey Spring	
G.	660413	ASU 2401	Koehn	Sonoita Creek, Monkey Spring	
H.	670000	ASU 4849	Minckley	Sonoita Creek, Monkey Spring	

Table C-19. Sheehy Spring, Santa Cruz County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Other Species
70	390412	UMMZ 131103 listed as GIRO	Ashburn Gorsuch	"Shehe" Springs, San Rafael Valley, 0.5 mi from Santa Cruz River	22S 17E Sec. 3 (probably wrong)	AMME POOC
70	400906	SMNH 118423, 118424 listed as GIROIN	Ashburn	Santa Cruz River, 2 mi NE of Lochiel and at "Sheyhe" Spring		
70	500419	UMMZ 162671 listed as GIRO	Miller Winn	"Sheke" (Sheehy) Springs, 6 mi NE of "Sochcel" (Lochiel?)		
70	770316	ASU 8464	Johnson Rinne			
70	780401	ASU 7823	Minckley			
70	781114	ASU 8458	Landye Rinne			
70	801004	ASU 11472	Milstead			
70	891027	AGFD NFDB FFC OFC091	Not available	Sheehy Spring	24S 17E Sec. 11 NW4 NW4	GAAF
70	911026	AGFD NFDB FFC FC0830	Not available	Sheehy Spring	24S 17E Sec. 11 NE4	GAAF
70	930810	AGFD NFDB DAW001	Weedman	Sheehy Spring	24S 17E	GAAF

Table C-20. San Pedro River, Cochise, Pima, and Pinal counties, Arizona.

Date	Source	Collector	Descriptive Location	Other Species
040405	SMNH 129980 listed as GIROIN	Chamberlain	Fairbanks	AGCH CAIN MEFU PACL RHOS TICO
040406	SMNH 129974 listed as GIROIN	Chamberlain	1.5 mi above Fairbanks	CAIN
121005	SMNH 73717 listed as GIROIN	US Bureau of Fisheries	St. David	

Table C-21. Redfield Canyon, Graham and Pima counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A	610327	UMMZ 179800 listed as GIRO	Miller et al.	1 mi above stone cabin			
B	760426	ASU 6912	Silvey		11S 20E Sec. 31		CAIN AGCH
C	760809	ASU 6976	Frantz		11S 19E Sec. 35		AGCH RHOS
D	760810	ASU 6982	Frantz		11S 19E Sec. 36		CAIN AGCH RHOS
E	770423	ASU 7161	Thompson		11S 20E Sec. 29		CAIN RHOS
F	770423	ASU 7153	Thompson		11S 20E Sec. 32		CAIN RHOS
G	830417	ASU 1034140348	ASU				
H	830417	ASU 11647	Hendrickson	Redfield Canyon	11S 20ESec. 31 SE4 NE4		AGCH CAIN RHOS

Table C-21. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
I	920000 930000	AGFD NFDB TNC Annual Monitoring RDCRP1	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		AGCH CAIN
J	920000 930000	AGFD NFDB TNC Annual Monitoring RDCRP2	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		CAIN LECY
K	920000	AGFD NFDB TNC Annual Monitoring RDCRP3	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		CAIN
L	920000	AGFD NFDB TNC Annual Monitoring RDCRP4	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		CAIN LECY RHOS
M	920000	AGFD NFDB TNC Annual Monitoring RDCRP5	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		AGCH CAIN PACL RHOS
N	920000	AGFD NFDB TNC Annual Monitoring RDCRP6	Gori	Redfield Canyon, randomly sampled pool	11 S 20E Sec. 32		CAIN RHOS
58	891203 902101	AGFD NFDB FFC OFC441, FC4420	Not available	Redfield Canyon, above stone ranch house	11S 19E Sec. 35 NE4 NW4 SW4	322557 1102255	AGCH CAIN LECY PACL RHOS
59.	881009	AGFD NFDB FFC OFC441	Not available	Redfield Canyon, 7 mi upstream of Redington	11S19E Sec. 35 SW4	322555 1102242	AGCH CAIN LECY PACL PIPR RHOS

Table C-21. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
60.	881009 901201	AGFD NFDB FFC OFC443, FC4430	Not available	Redfield Canyon, Below stone Ranch house	11S 19E Sec. 35 NE4 SE4 SW4	322557 1102215	AGCH CAIN LECY PACL RHOS
61.	910000 920000 930000 940000	AGFD NFDB TNC Annual Monitoring RDC001	Gori	Redfield Canyon	11S 20E Sec. 28 NW4 SE4	322642 1101858	AGCH
62.	910000 920000 930000 940000	AGFD NFDB TNC Annual Monitoring RDC002	Gori	Redfield Canyon	11S 20E Sec. 32 NE4 NE4	322627 1101922	AGCH CAIN RHOS
63.	910000 920000 930000	AGFD NFDB TNC Annual Monitoring RDC003	Gori	Redfield Canyon	11S 20E Sec. 32 NW4 NE4	322618 1101930	AGCH CAIN RHOS
64.	910000 920000 930000 940000	AGFD NFDB TNC Annual Monitoring RDC004	Gori	Redfield Canyon	11S 20E Sec. 32 SW4 NE4	322610 1101932	AGCH CAIN RHOS
65.	910000 920000	AGFD NFDB TNC Annual Monitoring RDC005	Gori	Redfield Canyon	11S 20E Sec. 32 SE4 NE4	322610 1101925	AGCH CAIN LECY RHOS
66.	910000 920000 930000	AGFD NFDB TNC Annual Monitoring RDC006	Gori	Redfield Canyon	11S 20E Sec. 32 SE4 NW4	322603 1102010	AGCH CAIN LECY RHOS

Table C-22. Bass Canyon, Double R Creek and Hot Springs Creek, Graham and Cochise counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	770623	ASU 7454	Thompson	Bass Canyon,	12S 21E Sec. 31		PACL RHOS
B.	800520	ASU 8454	Mills	Bass Canyon, at 4050' elevation	12S 21E Sec. 31		
C.	891026	AGFD NFDB FFC OFC451	Gori	Bass Canyon, Below Pattersons Cabin	12S 21E Sec. 31		AGCH CAIN MISA PACL RHOS
D.	930000 940000	AGFD NFDB TNC Annual Monitoring BASRP1	Gori	Bass Canyon, randomly sampled pool	12S 20E		AGCH CAIN PACL RHOS
E.	920000	AGFD NFDB TNC Annual Monitoring BASRP2	Gori	Bass Canyon, randomly sampled pool	12S 20E		AGCH CAIN PACL RHOS
F.	920000 930000 940000	AGFD NFDB TNC Annual Monitoring BASRP3	Gori	Bass Canyon, randomly sampled pool	12S 20E		AGCH CAIN PACL RHOS
G.	940000	AGFD NFDB TNC Annual Monitoring BASRP4	Gori	Bass Canyon, randomly sampled pool	12S 20E		CAIN PACL
H.	920000 940000	AGFD NFDB TNC Annual Monitoring BASRP5	Gori	Bass Canyon, randomly sampled pool	12S 20E		AGCH CAIN PACL RHOS
I.	930000	AGFD NFDB TNC Annual Monitoring BASRP6	Gori	Bass Canyon, randomly sampled pool	12S 20E		AGCH PACL
J.	930000	AGFD NFDB TNC Annual Monitoring HSC004	Gori	Hot Springs Creek	12S 20E Sec. 27 SE4 SE4	322125 1101715	AGCH CAIN PACL RHOS

Table C-22. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
K.	930000	AGFD NFDB TNC Annual Monitoring **HSC005**	Gori	Hot Springs Creek	12S 20E Sec. 27 SE4 SW4	322114 1101747	AGCH PACL RHOS
2.	881113	AGFD NFDB FFC **OFC454**	Howell Hastings	Bass Canyon, **pool** about 150m upstream in roots at base of large tree	12S 21E Sec. 31 NW4 NW4	322104 1101416	AGCH CAIN RHOS
3.	881113	AGFD NFDB FFC **OFC453**	Howell Hastings	Bass Canyon, pool with vertical rock face and overhang	12S 21E Sec. 31 NW4 NW4	322104 1101416	AGCH CAIN PACL RHOS
4.	910000 920000 930000 940000	AGFD NFDB TNC Annual Monitoring **BAS001**	Gori	Bass Canyon	12S 20E Sec. 29 NE4 NW4	322150 1101337	AGCH CAIN PACL RHOS
5.	910000 940000	AGFD NFDB **TNC** Annual Monitoring **BAS002**	Gori	Bass Canyon	12S 20E Sec. 29 NE4 SW4	322139 1101341	AGCH CAIN PACL RHOS
6.	910000 930000 940000	AGFD NFDB TNC Annual Monitoring **BAS003**	Gori	Bass Canyon	12S 20E Sec. 29 NE4 SW4	322133 1101341	AGCH CAIN PACL RHOS
7.	910000 930000 940000	AGFD NFDB TNC Annual Monitoring **BAS004**	Gori	Bass Canyon	12S 20E Sec. 29 NE4 SW4	322130 1101345	AGCH CAIN PACL RHOS
8.	910000 940000	AGFD NFDB TNC Annual Monitoring **BAS005**	Gori	Bass Canyon	12S 20E Sec. 29 SE4 SW4	322125 1101345	AGCH PACL RHOS
9.	910000 920000 930000 940000	AGFD NFDB TNC Annual Monitoring **BAS006**	Gori	Bass Canyon	12S 20E Sec. 31 NE4 NW4	322107 1101440	AGCH CAIN PACL **RHOS**

Table C-22. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
10.	910000 940000	AGFD NFDB TNC Annual Monitoring BAS007	Gori	Bass Canyon	12S 20E Sec. 31 NW4 NW4	322100 1101450	AGCH CAIN PACL RHOS
11.	910000 930000 940000	AGFD NFDB TNC Annual Monitoring BAS008	Gori	Bass Canyon	12S 20E Sec. 36 SE4 NE4	322054 1101512	AGCH CAIN PACL RHOS
43.	930000	AGFD NFDB TNC Annual Monitoring DRC003	Gori	Double R Creek	12S 21E Sec. 31 NE4 NE4	321412 1102112	AGCH RHOS
44.	940000	AGFD NFDB TNC Annual Monitoring DRC001	Gori	Double R Creek	12S 21E Sec. 30 NW4 NE4	321428 1102200	AGCH PACL RHOS
45.	910000	AGFD NFDB TNC Annual Monitoring HSC002	Gori	Hot Springs Creek	12S 20E Sec. 25 SW4 SW4	322116 1101550	AGCH CAIN PACL RHOS
46.	930000	AGFD NFDB TNC Annual Monitoring HSC001	Gori	Hot Springs Creek	12S 20E Sec. 25 SE4 SW4	322116 1101535	AGCH CAIN PACL RHOS

Table C-23. Babocomari River, Santa Cruz and Cochise counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	(18)920522	SMNH 46097-46099 listed as GIROIN	Fisher	near Ft. Huachuca			
B.	500426	UMMZ 162696	Not available	3.5 mi below Babocomari Ranch			CAIN PACL AGCH
C.	670000	ASU 6852	Rinne	.5 mi E of Babocomari Ranch			
D.	670430	ASU 2763	Minckley Johnson	7.4 mi NW of Ft. Huachuca			CAAU CAIN PACL LEMA
E.	680300	ASU 4911	Minckley	.5 mi E of Babocomari Ranch			CAIN PACL
F.	680328	ASU 6851	Rinne Jensen	.5 mi E of Babocomari Ranch			
G.	680412	ASU 4845	Minckley	.5 mi E of Babocomari Ranch			CAIN PACL AGCH LEMA MISA CAAU
1.	880916	AGFD NFDB FFC OFC462 & OFC463	Warren Howell	T-4 Spring 100 m and 200 m upstream of stock pond	21S 18E	313803 1102848	AGCH

Table C-24. O'Donnell Canyon, Santa Cruz County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	781117	ASU 8461	Johnson	O'Donnell Creek at TNC Ranch			
B.	830608	ASU 10349-10352	DeMarais	O'Donnell Creek			
85.	770504	AGFD Files	O'Brien Ginnelly	O'Donnell Creek, 1/4 mile stretch of USFS land between TNC property	T21S R18E Sec. 33 NE4 of NW4		AGCH CAIN
52.	890726	AGFD NFDB BEB005	Bagley	O'Donnell Canyon	21S 18E Sec. 28 SW4 SE4	313423 1103115	
	920617	AGFD NFDB DAW003	Weedman	O'Donnell Canyon	same as above	same	LECY
	930811	AGFD NFDB DAW002	Weedman	O'Donnell Canyon	same as above	same	LECY AGCH
53.	910000 920000 940000	AGFD NFDB TNC Monitoring ODC001	Gori	O'Donnell Canyon	21S 18E Sec. 33 NW4 SW4	313350 1103138	CAIN LECY AGCH
54.	910000 940000	AGFD NFDB TNC Monitoring ODC002	Gori	O'Donnell Canyon	21S 18E Sec. 33 NE4 NW4	313408 1103125	AGCH CAIN LECY
55.	910000 940000	AGFD NFDB TNC Monitoring ODC003	Gori	O'Donnell Canyon	21S 18E Sec. 33 NE4 NW4	313415 1103119	AGCH CAIN LECY
56.	910000 940000	AGFD NFDB TNC Monitoring ODC004	Gori	O'Donnell Canyon	21S 18E Sec. 28 SE4 SW4	313420 1103115	LECY CAIN
57.	890726	AGFD NFDB BEB003	Bagley	Post Canyon	21S 18E Sec. 28 SW4 NW4	313450 1103134	
86.	950828	AGFD NFDB DAW002	Weedman	O'Donnell Canyon	21S 18E Sec. 28 NE4 SW4 SE4		
87.	950829	AGFD NFDB DAW002	Weedman	O'Donnell Canyon	21S 18E Sec. 33 NW4		CAIN LECY

Table C-25. Turkey Creek, Santa Cruz County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	520316	Lowe's Collection at UofA	Not available	Turkey Creek, at Canelo			AGCH
B.	770316	ASU 8522	Rinne	Turkey Creek			
C.	790319	ASU 8186	Helseth	Turkey Creek, at Canelo Forest Service Admin. Site	T22S R18E Sec. 4 NE4		
D.	830608	ASU 11561	DeMarais	Turkey Creek			
E.	830608	ASU 10353-10363	DeMarais	Turkey Creek			
F.	850315	ASU 11668	DeMarais	Turkey Creek, below Canelo			
G.	850504	ASU 10454	DeMarais	Turkey Creek, crossing at Canelo FS Admin. Site			
H.	850507	ASU 10456	Stromberg	Turkey Creek, at Ranch headquarters	T21S R18E Sec. 33		
I.	860912	ASU 10670	Simons	Turkey Creek, at southern boundary of Audubon Research Ranch	T22S R 18E Sec. 4		
78	910730	AGFD NFDB MRB001	Brown	Turkey Creek	22S 18E Sec. 4 E1/2	335601 1103045	

Table C-26. Bonita Creek, Graham County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	**500502**	**UMMZ 162710** listed as GIRO	Miller Winn	near confluence with Gila River			**PACL** CAIN **AGCH TICO** RHOS
93.	**690629**	**ASU 4690**	**Rinne**	at Bear Canyon NW of Ranch			**PACL** CAIN **AGCH** RHOS
C.	**770624**	**ASU 7218**	**Minckley**	at **3650'** elevation			
D.	**780204**	**ASU 7742**	Clarkson	at **3810'** elevation			**AGCH**
E.	**780204**	**ASU 7738**	Clarkson	at **3690'** elevation			**AGCH** CAIN **PACL**
94.	**780326**	**ASU 7851**	**AGFD**	at **3250'** elevation			CAIN **PACL AGCH CYLU** RHOS **PIPR**
G.	**780421**	**ASU 7886**	Clarkson	at **3760'** elevation			CAIN **PACL AGCH**
H.	**780421**	**ASU 7883**	Clarkson	at **3840'** elevation			**PACL AGCH**
I.	**780804**	**ASU 7984**	Clarkson	at **3700'** elevation			CAIN **PACL**
J.	**830517**	**ASU 10411-10415**	DeMarais	Bonita Creek			
K.	**851015**	**ASU 10531**	Brooks	lower backwater			
13.	**931209**	**AGFD NFDB JRS001**	Simms	Bonita Creek	**5S 27E** Sec. **23 S1/2**	**325847 1093230**	**AGCH** CAIN **PACL** RHOS
14.	**931209**	**AGFD NFDB JRS002**	Simms	**Bonita** Creek	**5S 27E** Sec. **23** Center	**325856 1093245**	**AGCH** CAIN **PACL** RHOS
15.	**931209**	**AGFD NFDB JRS003**	Simms	Bonita Creek	**5S 27E** Sec. **23 N1/2**	**325910 1093238**	**AGCH** CAIN **PACL** RHOS
16.	**931209**	**AGFD NFDB JRS004**	Simms	Bonita Creek	**5S 27E** Sec. **14 S1/2**	**325948 1093242**	**AGCH** CAIN **PACL** RHOS

Table C-26. Continued.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
17.	931209	AGFD NFDB JRS005	Simms	Bonita Creek	5S 27E Sec. 14 N1/2 of S1/2	325958 1093247	AGCH CAIN PACL
18.	931209	AGFD NFDB JRS006	Simms	Bonita Creek	5S 27E Sec. 14 Center	325951 1093241	CAIN PACL
19.	931209	AGFD NFDB JRS007	Sinuns	Bonita Creek	5S 27E Sec. 14 S1/2 of N1/2	325943 1093243	CAIN PACL
20.	931209	AGFD NFDB JRS008	Simms	Bonita Creek	5S 27E Sec. 14 N1/2	330009 1093253	AGCH CAIN PACL RHOS
21.	931209	AGFD NFDB JRS009	Simms	Bonita Creek	5S 27E Sec. 14 N1/2 of N1/2	330007 1093252	AGCH CAIN PACL RHOS
22.	931209	AGFD NFDB JRS010	Simms	Bonita Creek	5S 27E Sec. 11 SW4 SW4	330027 1093255	AGCH CAIN PACL RHOS
23.	931210	AGFD NFDB JRS001	Simms	Bonita Creek	4S 27E Sec. 34 S1/2	330228 1093340	AGCH CAIN PACL RHOS
24.	931210	AGFD NFDB JRS002	Simms	Bonita Creek	4S 27E Sec. 3 N1/2	330210 1093341	AGCH CAIN PACL RHOS
25.	931210	AGFD NFDB JRS003	Simms	Bonita Creek	4S 27E Sec. 34 S1/2	330153 1093343	AGCH CAIN PACL RHOS
26.	931210	AGFD NFDB JRS004	Simms	Bonita Creek	5S 27E Sec. 3 N1/2	330143 1093345	AGCH CAIN PACL RHOS

Table C-27. Eagle Creek, Graham and Greenlee counties, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Other Species
A	340727	UMMZ 216958 listed as GIRO	Madsen	Eagle Creek, 100 yds. Above Honey Moon Ranch		
B	390300	UMMZ 131126 listed as intergrade	Gorsuch	East Eagle Creek, N of Clifton		
C	500508	UMMZ 162745 listed as intergrade	Miller et al.	3.4 to 4 mi S of Eagle Ranger Station, in Box Canyon	T5S R29E Sec. 31, NW4 NE4	PACL CAIN AGCH RHOS TICO
D	500508	UMMZ 162744, 162746 (listed as GIRO)	Miller et al.	3.4 to 4 mi S of Eagle Ranger Station, in Box Canyon	T5S R29E Sec. 31, NW4 NE4	PACL CAIN AGCH RHOS TICO
E		DeMarais (1986) uncat. specimens				
79.	780326	ASU 7836	Clarkson	Honeymoon Campground at 5400' elevation	T2N R28E Sec. 31, NE4 SE4	

Table C-28. San Simon Cienega, Cochise County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Other Species
A.	390720	UMMZ 137093, reported as intergrade GIROxGIIN	Not available	San Simon Cienega, 1 mile north of Warner Ranch	AMME

Table C-29. Harden Cienega Creek, Greenlee County, Arizona.

Reference Id.	Date	Source	Collector	Descriptive Location	Township Range	Latitude Longitude	Other Species
A.	880711	ASU 12171	DeMarais	Not Available			

THE STATE OF ARIZONA

GAME & FISH DEPARTMENT

2221 West Greenway Road, Phoenix, Arizona 85023-4399 (602) 942-3000

February 8, 1996

Dr. W.L. Minckley
Department of Zoology
Arizona State University
Tempe, Arizona

Dear Dr. Minckley:

Enclosed for your review is the draft report "Status review of Gila chub, *Gila intermedia,* in the United States and Mexico." Please take this opportunity to provide any comments you have. In order to meet our deadline for submission of the Final Report to The Nature Conservancy, please provide your comments by **February 29.** Comments can be provided in a separate summary or simply write your comments and make corrections directly on the manuscript and return it. If necessary, focus only on those areas of which you have personal knowledge. Please include data or references for additional information on field surveys or land uses.

If you have any questions, or would like to discuss any issues related to the report, please give me or Dave Weedman a call at 789-3513.

Sincerely,

Kirk Young
Native Fish Program Manager

KLY:dw

cc: Dennis Kubly

Enclosure