expenditure of these funds. Fund transfers will occur before the end of each Federal fiscal year. We will submit a brief annual report to Reclamation that details expenditures of the fund and how they contributed to nonindigenous aquatic species control and to recovery of listed fishes in the Gila River basin.

Information and Education

The purpose of this action is to increase public awareness of the value of native aquatic species and to educate the public about the problems that nonindigenous species create for conservation and recovery of native species and their habitats. Reclamation will seek opportunities to develop or fund informational and educational programs that meet these goals within major metropolitan areas of the Gila River basin during the 100-year life of the CAP. Reclamation will provide copies of any media materials produced because of this program to the CAP Policy and Technical committees. The 1994 and 2001 biological opinions provide additional detail for this conservation measure (USFWS 1994, 2001c) and are incorporated here by reference.

Chiricahua leopard frog "head start" Program

The primary purpose of this action is to fund the development of a facility or augment existing facilities at the Phoenix Zoo and Arizona-Sonora Desert Museum that will rear Chiricahua leopard frog eggs to late-stage tadpole or metamorph life stages before release back in the wild. This action will bypass a major mortality bottleneck in the life history of the frog and better ensure recruitment of frogs to adulthood. This fund may also be used for other conservation actions for Chiricahua leopard frog, pending approval by Reclamation, as appropriate and necessary. A single transfer of $100,000 (not including administrative costs) to the Service for facility development or augmentation or other conservation actions will be made within three years of the completion of this consultation.

STATUS OF THE SPECIES (Range-wide)

Gila topminnow (*Poeciliopsis o. occidentalis*)

Gila topminnow was listed as endangered in 1967 without critical habitat (32 FR 4001). Only Gila topminnow populations in the United States, and not in Mexico, are listed under the ESA. The reasons for decline of this fish include past dewatering of rivers, springs and marshlands, impoundment, channelization, diversion, regulation of flow, land management practices that promote erosion and arroyo formation, and the introduction of predacious and competing nonindigenous fishes (Miller 1961, Minckley 1985). Other listed fish suffer from the same impacts (Moyle and Williams 1990). Life history information can be found in the 1984 recovery plan (USFWS 1984a), the draft revised Gila topminnow recovery plan (Weedman 1999), and references cited in the plans.

Gila topminnow was listed as *Poeciliopsis occidentalis*. The species was later revised to include two subspecies, *P. o. occidentalis* and *P. o. sonoriensis* (Minckley 1969, 1973). *P. o.*

occidentalis is known as the Gila topminnow, and *P. o. sonoriensis* is known as the Yaqui topminnow. Publications by Minckley (1999) and Hedrick et al. (2001b), consider Gila topminnow and Yaqui topminnow to be separate species, *P. occidentalis* and *P. sonoriensis*, respectively. This separation is based partly on information presented by Quattro et al. (1996). The Service has not published a technical correction in the Federal Register to reflect the name changes. Therefore, the taxa listed under the Endangered Species Act are *P. o. occidentalis* and *P. o. sonoriensis*. Both Gila and Yaqui (sub) species receive full protection under the Endangered Species Act, although this taxonomic clarification has not been made.

Historically, the Gila topminnow was abundant in the Gila River drainage and was one of the most common fishes of the Colorado River basin, particularly in the Santa Cruz system (Hubbs and Miller 1941). Its status in the wild was reduced to only 15 naturally occurring populations by the time the species was federally listed. Presently, only 11 of the 15 recent natural Gila topminnow populations are considered extant (Table 5) (Voeltz and Bettaso 2003). Only four (Cienega Creek, Monkey Spring, Cottonwood Spring, Fresno Canyon) have no nonindigenous fish present and therefore can be considered currently secure from nonindigenous fish threats. There have been at least 175 wild sites stocked with Gila topminnow, however, topminnow persist at only 18 of these localities. Of the 18, one site is outside topminnow historical range and four contain nonindigenous fish (Voeltz and Bettaso 2003).

The Gila topminnow is highly vulnerable to adverse effects from nonindigenous aquatic species (Johnson and Hubbs 1989). Predation and competition from nonindigenous fishes have been a major factor in its decline and continue to be a major threat to the remaining populations (Meffe et al. 1983, Meffe 1985, Brooks 1986, Marsh and Minckley 1990, Stefferud and Stefferud 1994, Weedman and Young 1997). The native fish fauna of the Gila basin and of the Colorado basin overall, was naturally depauperate and contained few fish that were predatory on or competitive with Gila topminnow (Carlson and Muth 1989). In the riverine backwater and side-channel habitats that formed the bulk of Gila topminnow natural habitat, predation and competition from other fishes was essentially absent. Thus, Gila topminnow did not evolve mechanisms for protection against predation or competition and is predator- and competitor-naive. With the introduction of many predatory and competitive nonindigenous fish, frogs, crayfish, and other species, Gila topminnow could no longer survive in many of its former habitats, or the small pieces of those habitats that had not been lost to human alteration. Both large (Bestgen and Propst 1989) and small (Meffe et al. 1983) nonindigenous fish cause problems for Gila topminnow.

The status of the species is poor and declining. Gila topminnow has gone from being one of the most common fishes of the Gila basin to one that exists at not more than 30 localities (11 natural and 20 stocked). Many of these localities are small and highly threatened. The theory of island biogeography can be applied to these isolated habitat remnants, as they function similarly (Meffe 1983, Laurenson and Hocutt 1985). Species on islands are more prone to extinctions than continental areas that are similar in size (MacArthur and Wilson 1967). Meffe (1983) considered extinction of Gila topminnow populations almost as critical as recognized species extinctions. Moyle and Williams (1990) noted that fish in California that are in trouble tend to be endemic,

Table 5. Status of natural Gila topminnow populations in the U.S. (Service files, Weedman and Young 1997, Voeltz and Bettaso 2003).

Site	Ownership	Extant?[1]	Nonindigenous species?	Mosquitofish?	Habitat Size[2]	Threats[3]
Bylas Spring[5]	San Carlos	YES	NO[4]	NO[4]	S D	M/ N G
Cienega Creek	BLM	YES	NO	NO	L	M/ R N D
Cocio Wash	BLM	NO 1982	UNKNOWN	UNKNOWN	S	H/ M
Cottonwood Spring	Private	YES	NO	NO	S	M/ N D W
Fresno Canyon	State Parks	YES	NO	NO[4]	M	H/ G U
Middle Spring[5]	San Carlos	YES	NO[4]	NO[4]	S	H/ N G
Monkey Spring	Private	YES	NO	NO	S	L/ W U
Redrock Canyon	USFS	NO 2005	YES	YES	M D	H/ W R G N D
Sabino Canyon	USFS	NO 1943	YES	NO	M	H/ R N
Salt Creek[5]	San Carlos	YES	NO[4]	NO[4]	S	M/ N G
San Pedro River	Private	NO 1976	YES	YES	-	H/ W N G R
Santa Cruz River San Rafael Tumacacori Tucson	Private, State Parks, TNC	NO[6] YES NO 1943	YES YES[4] YES	YES YES NO	L D	H/ W N R G C U
Sharp Spring	State Parks	NO 2004	YES	YES	M	H/ N G U D
Sheehy Spring	TNC	NO 1987	YES	YES	S	H/ N G U
Sonoita Creek	Private, TNC, State Parks	YES	YES	YES	L D	H/ W N G
Tonto Creek	Private, USFS	NO 1941	YES	YES	L	H/ N R G W

[1] if no, last year recorded
[2] L = large M= medium S = small D = disjunct
[3] Immediacy H = high M = moderate L = low
Type W = water withdrawal C = contaminants R = recreation N = nonindigenous species
G = grazing M = mining D = drought
U = urbanization
[4] none recently, they have been recorded
[5] recently renovated
[6] in Mexico 2006, U.S. in 1993 (Service files)

restricted to a small area, part of fish communities with fewer than five species, and found in isolated springs or streams. Gila topminnow has most of these characteristics.

The Sonoran Topminnow Recovery Plan (USFWS 1984a) established criteria for down- and de-listing. Criteria for down-listing were met for a short period. However, due to concerns regarding the status of several populations, down-listing was delayed. Subsequently, the number of reestablished populations dropped below that required for down-listing, where it has remained. The Yaqui topminnow is now included within the Yaqui Fishes Recovery Plan (USFWS 1995). A draft revised recovery plan for the Gila topminnow is available (Weedman 1999). The plan's short-term goal is to prevent extirpation of the species from its natural range in the U.S. and reestablish it into suitable habitat within its historical range. Downlisting criteria require a minimum of 82 reestablished populations, some of which have persisted at least 10 years.

Razorback sucker (*Xyrauchen texanus*)

The razorback sucker was listed as an endangered species on November 22, 1991, (56 FR 54957). Critical habitat for the razorback sucker was designated in 1994, and includes rivers in Colorado, Utah, portions of the Colorado River in Arizona, California, and Nevada, and portions of the Gila, Salt, and Verde rivers in Arizona (59 FR 10898). When we designated critical habitat, we determined the primary constituent elements (PCEs) for razorback sucker. Constituent elements include those habitat features required for the physiological, behavioral, and ecological needs of the species (59 FR 10898). For razorback sucker, these include:

1) Water: this includes a quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location following a hydrologic regime that is required for each life stage.

2) Physical habitat: this includes areas of the Colorado River system that are inhabited or potentially inhabitable by fish for use in spawning, nursery, feeding, and rearing, or corridors between these areas. In addition to river channels, these areas also include bottom lands, side channels, secondary channels, oxbows, backwaters, and other areas within the 100-year

floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.

3) Biological environment: food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although considered normal components of this environment, are out of balance due to introduced nonindigenous fish species in many areas.

In addition to the primary constituent elements, we used additional selection criteria to determine critical habitat for the razorback sucker. These criteria are:

A. Presence of known or suspected wild spawning populations, although recruitment may be limited or nonexistent.

B. Areas where juvenile razorback suckers have been collected or which could provide suitable nursery habitat (backwaters, flooded bottom lands, or coves).

C. Areas presently occupied or that were historically occupied that are considered necessary for recovery and that have the potential for reestablishment of razorback suckers.

D. Areas and water required to maintain rangewide fish distribution and diversity under a variety of physical, chemical, and biological conditions.

E. Areas that need special management or protection to ensure razorback survival and recovery. These areas once met the habitats needs of the razorback sucker and may be recoverable with additional protection and management.

The razorback sucker is a catostomid fish endemic to the Colorado River basin. Small populations of wild razorback suckers exist in the upper basin in the Green River basin (the Green, Duchesne, White, and Yampa rivers) and the mainstem Colorado River in Colorado and Utah. Wild populations are considered extirpated in the Gunnison River in Colorado and the San Juan River in New Mexico. Aside from a small, undetermined number of wild fish in the Colorado River, most of the upper basin wild population is focused in the Green River basin, and was recently estimated at 108 individuals in 1999 (Bestgen et al. 2002), and hypothesized in that same paper to be less than half that number by 2001. In the lower basin, wild razorback sucker populations are known from Lakes Mead and Mohave. A very few wild individuals may still be found below Lake Mohave to Imperial Dam. The Lake Mead population is estimated at 100 to 200 individuals (Welker and Holden 2003, 2004). The Lake Mohave wild population was estimated at 2,698 in 2002 (Marsh et al. 2003) but has declined to an estimated 218 fish in 2007 (Kesner et al. 2008). Wild populations in Lake Havasu and the river between Parker Dam and Imperial Dam are extremely small, and past stocking activities with unmarked fish, especially in the Parker Dam-Imperial Dam reach, confuse the identification of fish captured there. Recent declines in numbers of wild fish are the result of the old adults that comprise these populations likely dying of old age. None of the populations are confirmed to be self-sustaining, with recent recruitment of wild-bred young only documented in Lake Mead (most recently in Welker and

Holden 2004). Some recruitment was assumed for a portion of the middle Green River (Modde et al. 1996), and captures of small razorback suckers in canals below Parker Dam on the Colorado River also represent some recruitment occurring in this area (summarized in USFWS 2001e). Additional monitoring in this area will be required to document recruitment. The recovery goals (USFWS 2002a) contain the most recent life history information on the species. Material in that publication is incorporated by reference.

Predation and competition from nonindigenous fish species introduced into the Colorado River basin pose the greatest threat to the razorback sucker. Other significant threats to the razorback sucker include loss of riverine and backwater habitats, loss of connectivity of habitats, and changed inflows due to water-development. Effects of pharmaceutical and personal care chemicals, particularly endocrine compounds, may be a threat to maturation and reproduction of adult razorbacks (Baker and Marr 2003).

Implementation of recovery actions (USFWS 1998b, 2002a) in the lower basin is accomplished through the cooperative efforts of Federal, state, and university entities, such as the Native Fish Work Group, and a considerable amount of the ongoing conservation is the result of conservation measures and reasonable and prudent alternatives contained in Federal projects and biological opinions. In addition to stocking sub-adult fish into Lake Mohave, Lake Havasu, and the reach below Parker Dam, there is also ongoing research into dispersal of stocked fish into the system, habitat preferences, and use; monitoring of spawning at Lake Mead and research into the reasons for successful recruitment to that population; and development of isolated habitats like that at Cibola High Levee Pond to provide secure areas for self-sustaining populations.

The Razorback Sucker Recovery Plan (USFWS 1998b) was updated and supplemented by the Razorback Sucker (*Xyrauchen texanus*) Recovery Goals in 2002 (USFWS 2002a). The recovery objectives call for protection and expansion of three existing populations, and establishment of five new ones from remnant stocks or reintroductions. The recovery actions below are necessary to recover the species:

1. Maintain existing genetic diversity in hatchery refuges and increase diversity if possible.

2. Reverse the decline, increase, and stabilize three existing populations by management actions: Lake Mohave, middle Green River, and lower Yampa River.

3. Protect habitats of these populations from further degradation.

4. Restore habitats to make them compatible with recovery goals.

5. Augment or reestablish five additional populations of the fish in its critical habitat.

Spikedace (*Meda fulgida*)

Spikedace was listed as a threatened species in 1986 (51 FR 23769). Critical habitat was designated on March 21, 2007 (72 FR 13356). Critical habitat includes portions of the Verde,

middle Gila, San Pedro, San Francisco, Blue, and upper Gila rivers and Eagle, Bonita, Tonto, and Aravaipa creeks and several tributaries of those streams. When we designated critical habitat, we determined the primary constituent elements for spikedace. Constituent elements include those habitat features required for the physiological, behavioral, and ecological needs of the species (72 FR 13356). For spikedace, these include:

1) Permanent, flowing water with no or minimal levels of pollutants (Baker 2005);

2) Living areas with appropriate flow velocities and depths for the various life stages of the fish, as follows:

PCE	Life stage of spikedace	Parameters
Flow velocities	Adult	8 to 24 in/sec (20-60 cm/sec)
	Juvenile	8+ in/sec (18+ cm/sec)
	Larval	4+ in/sec (10+ cm/sec)
Depth	Adult	4 to 40 in (3 cm-1 m)
	Juvenile	1.2 to 40 in (3 cm-1 m)
	Larval	1.2 to 40 in (3 cm-1 m)

(Barber and Minckley 1966, Anderson 1978, Schreiber 1978, Propst et al. 1986, Rinne and Kroeger 1988, Hardy 1990, Sublette et al. 1990, Rinne 1991);

3) Water with appropriate dissolved oxygen levels (about 3.5 cc/l [1 cu in/gal]) and no or minimal levels for pollutants such as copper, arsenic, mercury, and cadmium; human and animal waste products; pesticides; suspended sediments; and gasoline or diesel fuels (Baker 2005);

4) Sand, gravel, and cobble substrates with low or moderate amounts of fine sediment and substrate embeddedness. Appropriate substrate embeddedness is generally maintained by a natural, unregulated hydrograph that allows for periodic flooding, or if flows are modified or regulated, a hydrograph that allows for adequate river functions, such as flows capable of transporting sediments (Propst et al. 1986, Stefferud and Rinne 1996, Velasco 1997);

5) Streams that have low gradients of less than about one percent (Barber et al. 1970, Propst et al. 1986, Rinne and Kroeger 1988, Sublette et al. 1990, Neary et al. 1996, Rinne and Stefferud 1996, Stefferud and Rinne 1996, Rinne and Deason 2000, Rinne 2001);

6) Water temperatures in the range of 35 to 82 °F (2-28 °C) with additional natural daily and seasonal variation (Barber et al. 1970, Propst et al. 1986, Bonar et al. 2005);

7) Riffle, run, and backwater components (Barber and Minckley 1966, Barber et al. 1970, Anderson 1978, Montgomery 1985, Propst et al. 1986, Rinne and Stefferud 1996);

8) An abundant aquatic insect food base consisting of mayflies, true flies, caddisflies, stoneflies, and dragonflies (Anderson 1978, Schreiber 1978, Barber and Minckley 1983, Propst et al. 1986);

9) Habitat devoid of nonindigenous aquatic species or habitat in which nonindigenous aquatic species are at levels that allow persistence of spikedace (Miller 1961, Lachner et al. 1970, Anderson 1978, Ono et al. 1983, Minckley 1985, Williams et al. 1985, Moyle 1976, Moyle et al. 1986, Propst et al. 1986, Carlson and Muth 1989, Courtenay and Meffe 1989, Fuller et al. 1999, Minckley and Deacon 1991, Douglas et al. 1994, Lassuy 1995, Bonar et al. 2004), and;

10) Areas within perennial, interrupted stream courses that are periodically dewatered but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted.

The constituent elements are generalized descriptions and ranges of selected habitat factors that are critical for the survival and recovery of spikedace. The appropriate and desirable level of these factors may vary seasonally and is highly influenced by site-specific circumstances. Therefore, assessment of the presence or absence, and level or value of the constituent elements must include consideration of the season of concern and the characteristics of the specific location. The constituent elements are not independent of each other and must be assessed holistically, as a functioning system, rather than individually. In addition, the constituent elements need to be assessed in relation to larger habitat factors, such as watershed, floodplain, and streambank conditions, stream channel geomorphology, riparian vegetation, hydrologic patterns, and overall aquatic faunal community structure.

Spikedace is a small silvery fish whose common name alludes to the well-developed spine in the dorsal fin (Minckley 1973). Spikedace historically occurred throughout the mid-elevations of the Gila River drainage, but is currently known only from the middle and upper Gila River, the Verde River, and Aravaipa and Eagle Creek (Barber and Minckley 1966, Minckley 1973, Anderson 1978, Marsh et al. 1990, Sublette et al. 1990, Jakle 1992, Knowles 1994, Rinne 1999, Propst 2005, Paroz et al. 2006). Habitat destruction along with competition and predation from introduced nonindigenous species are the primary causes of the species' decline (Miller 1961, Williams et al. 1985, Douglas et al. 1994).

Recent taxonomic and genetic work on spikedace indicate there are substantial differences in morphology and genetic makeup between remnant spikedace populations. Remnant populations occupy isolated fragments of the Gila basin and are isolated from each other. Anderson and Hendrickson (1994) found that spikedace from Aravaipa Creek are morphologically distinguishable from spikedace from the Verde River, while spikedace from the upper Gila River and Eagle Creek have intermediate measurements and partially overlap the Aravaipa and Verde populations. Mitochondrial DNA and allozyme analyses have found similar patterns of geographic variation within the species (Tibbets 1992, 1993).

The status of spikedace is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted. A reclassification proposal is pending; however, it is precluded by work on higher priority listing actions (59 FR 35303). The FWS confirmed this decision in 2000 (65 FR 24328). Although spikedace is common in some portions of its highly reduced range, it is uncommon to rare in most. At present, the species is common only in Aravaipa Creek and some parts of the upper

Gila River in New Mexico. Populations in the Verde River and Eagle Creek have not been found since 1999 and 1987, respectively, and their status is uncertain (AGFD unpublished data, Marsh et al. 1989, Rinne 1999).

A recovery plan has been completed (USFWS 1991b). The recovery strategy calls for protecting existing populations, restoring populations in portions of historical habitat, and eventual delisting, if possible. The recovery actions below are necessary to recover the species:

1. Protection of existing populations.
2. Monitoring of existing populations.
3. Studies of interactions of spikedace and nonindigenous fishes.
4. Quantification of habitat and effects of habitat modification.
5. Enhancement of habitats of depleted populations.
6. Reestablishment of spikedace into its historical range.
7. Quantification of characteristics of a self-sustaining population.
8. Captive propagation.
9. Information and education.

Loach minnow (*Tiaroga cobitis*)

Loach minnow was listed as a threatened species in 1986 (51 FR 23769). Critical habitat was designated on March 21, 2007 (72 FR 13356). In Arizona, the current designation includes portions of the Black River, East Fork Black River, North Fork East Fork Black River, and Boneyard Creek; Aravaipa Creek and its tributaries Deer and Turkey creeks; the San Francisco River; Eagle Creek; and the Blue River and its tributaries, Campbell Blue Creek and Little Blue Creek. In New Mexico, the current designation includes portions of the Blue River; the San Francisco River and its tributary Whitewater Creek; the Tularosa River and its tributary, Negrito Creek; Campbell Blue Creek; Dry Blue Creek and its tributaries Frieborn and Pace creeks; and the Gila River, including portions of its West, Middle, and East forks. When we designated critical habitat, we determined the primary constituent elements for loach minnow. Constituent elements include those habitat features required for the physiological, behavioral, and ecological needs of the species (72 FR 13356). For loach minnow, these include:

1) Permanent, flowing water with no or minimal levels of pollutants (Baker 2005);

2) Living areas with appropriate flow velocities and depths for the various life stages of the fish, as follows:

PCE	Life stage of loach minnow	Parameters
Flow velocities	Adult	9 to 32 in/sec. (24-80 cm/sec)
	Juvenile	1 to 34 in/sec (3-85 cm/sec)
	Larval	3 to 20 in/sec (9-50cm/sec)
Depth	Adult	1 to 30 in (3-75 cm)
	Juvenile	1 to 30 inches (3-75 cm)
	Larval	shallow areas

Spawning areas are also required, and should have slow to swift flow velocities in shallow water where cobble and rubble and the spaces between them are not filled in by fine dirt or sand (Barber and Minckley 1966, Propst et al. 1988, Rinne 1989, Propst and Bestgen 1991).

3) Water with dissolved oxygen levels (about 3.5 cc/l or greater [1 cu in/gal]) and no or minimal pollutant levels for pollutants such as copper, arsenic, mercury, and cadmium; human and animal waste products; pesticides; suspended sediments; and gasoline or diesel fuels (Baker 2005);

4) Sand, gravel, and cobble substrates with low or moderate amounts of fine sediment and substrate embeddedness, which are generally maintained by a natural, unregulated hydrograph that allows for periodic flooding, or, if flows are modified or regulated, a hydrograph that allows for adequate river functions, such as flows capable of transporting sediments (Propst and Bestgen 1981, Propst et al. 1984, Propst et al. 1988, Rinne 1989, Rinne 2001).

5) Streams that have low gradients of less than about 2.5 percent (Rinne 1989, Rinne 2001).

6) Water temperatures in the range of 35 to 82 °F (2-28 °C) with additional natural daily and seasonal variation (Britt 1982, Propst et al. 1988, Leon 1989, Vives and Minckley 1990, Propst and Bestgen 1991, Bonar et al. 2005).

7) Pool, riffle, and run habitat components (Barber and Minckley 1966, Britt 1982, Propst et al. 1984, Montgomery 1985, Propst et al. 1988, Rinne 1989, Vives and Minckley 1990, Propst and Bestgen 1991, AGFD 1994, Bagley et al. 1995, Marsh et al. 2003).

8) An abundant aquatic insect food base consisting of mayflies, true flies, black flies, caddis flies, stoneflies, and dragonflies (Propst et al. 1988, Schreiber 1978, Propst and Bestgen 1991).

9) Habitat devoid of nonindigenous aquatic species or habitat in which nonindigenous aquatic species are at levels that allow persistence of spikedace (Miller 1961, Lachner et al. 1970, Anderson 1978, Ono et al. 1983, Minckley 1985, Williams et al. 1985, Moyle 1986, Moyle et al. 1986, Propst et al. 1986, Carlson and Muth 1989, Courtenay and Meffe 1989, Fuller et al. 1999, Minckley and Deacon 1991, Douglas et al. 1994, Lassuy 1995, Bonar et al. 2004), and;

10) Areas within perennial, interrupted stream courses that are periodically dewatered but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted.

The constituent elements are generalized descriptions and ranges of selected habitat factors that are critical for the survival and recovery of loach minnow. The appropriate and desirable level of these factors may vary seasonally and is highly influenced by site-specific circumstances. Therefore, assessment of the presence or absence, and level or value of the constituent elements must include consideration of the season of concern and the characteristics of the specific location. The constituent elements are not independent of each other and must be assessed holistically, as a functioning system, rather than individually. In addition, the constituent elements need to be assessed in relation to larger habitat factors, such as watershed, floodplain, and streambank conditions, stream channel geomorphology, riparian vegetation, hydrologic patterns, and overall aquatic faunal community structure.

Loach minnow is a small fish within the minnow family Cyprinidae. Loach minnow are olivaceous in color, and highly blotched with darker spots. Whitish spots are present at the front and back edges of the dorsal fin, and on the dorsal and ventral edges of the caudal fin. A black spot is usually present at the base of the caudal fin. Breeding males have bright red-orange coloration at the bases of the paired fins and on the adjacent body, on the base of the caudal lobe, and often on the abdomen. Breeding females are usually yellowish on the fins and lower body (Minckley 1973, USFWS 1991a).

Loach minnow is endemic to the Gila River basin of Arizona and New Mexico within the United States, and Sonora, Mexico, where it was recorded only in the Rio San Pedro. Historically, loach minnow in Arizona was found in the Salt River mainstem near and above the Phoenix area, the White River, East Fork White River, North Fork White River, Verde River, Gila River, San Pedro River, Aravaipa Creek, San Francisco River, Blue River, and Eagle Creek, as well as some tributaries of these streams. In New Mexico, loach minnow historically occupied the Gila River including its West, Middle, and east Forks; the San Francisco River; the Tularosa River; and Dry Blue Creek (Minckley 1973, Minckley 1985).

The limited taxonomic and genetic data available for loach minnow indicate there are substantial differences in morphology and genetic makeup among remnant loach minnow populations. Tibbets (1993) concluded that results from mitochondrial DNA and allozyme surveys indicate variation for loach minnow follows drainage patterns, suggesting little gene flow among rivers. The levels of divergence present in the data set indicated that populations within rivers are unique, and represent evolutionarily independent lineages. The main difference between the mtDNA and allozyme data was that mtDNA suggest that the San Francisco/Blue and Gila groups of loach minnow are separate, while the allozyme data places the Gila group within the San Francisco/Blue group. Tibbets (1993) concluded that the level of divergence in both allozyme and mtDNA data indicated that all three main populations (Aravaipa Creek, Blue/San Francisco Rivers, and Gila River) were historically isolated and represent evolutionarily distinct lineages.

The status of loach minnow is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted (59 FR 35303). The FWS confirmed this decision in 2000 (65 FR 24328). A reclassification proposal is pending; however, it is precluded by higher priority listing actions (59 FR 35303). In its highly reduced remaining range, loach minnow varies from common to rare. The species is

common only in Aravaipa Creek, the Blue River, and limited portions of the San Francisco, upper Gila and Tularosa Rivers. Remnant populations in the Black, White, and Eagle Creeks are very small and their continued existence is tenuous.

A recovery plan has been completed (USFWS 1991b). The recovery strategy calls for protecting existing populations, restoring populations in portions of historical habitat, and eventual delisting, if possible. The recovery actions below are necessary to recover the species:

1. Protection of existing populations.
2. Monitoring of existing populations.
3. Studies of interactions of loach minnow and nonindigenous fishes.
4. Quantification of habitat and effects of habitat modification.
5. Enhancement of habitats of depleted populations.
6. Reestablishment of loach minnow into its historical range.
7. Quantification of characteristics of a self-sustaining population.
8. Captive propagation.
9. Information and education.

Gila chub (*Gila intermedia*)

The Gila chub was listed as endangered with critical habitat on November 2, 2005, (70 FR 66664). Historically, Gila chub was recorded from rivers, streams, and spring-fed tributaries throughout the Gila River basin in southwestern New Mexico, central and southeastern Arizona, and northern Sonora, Mexico (Rinne and Minckley 1970, Minckley 1973, Rinne 1976, DeMarais 1986, Weedman et al. 1996). Today the Gila chub is restricted to small, isolated populations scattered throughout its historical range.

Critical habitat for Gila chub includes about 163 mi (262 km) of stream reaches in Arizona and New Mexico (70 FR 66664). When we designated critical habitat, we determined the primary constituent elements for Gila chub. Constituent elements include those habitat features required for the physiological, behavioral, and ecological needs of the species. For Gila chub, these include:

1) Perennial pools, areas of higher velocity between pools, and areas of shallow water among plants or eddies all found in headwaters, springs, and cienegas, generally of smaller tributaries;

2) Water temperatures for spawning ranging from 63 to 75 °F (17-24 °C), and seasonally appropriate temperatures for all life stages (varying from about 50 to 86 °F [10 °C to 30 °C]);

3) Water quality with reduced levels of contaminants, including excessive levels of sediments adverse to Gila chub health, and adequate levels of pH (e.g. ranging from 6.5-9.5), dissolved oxygen (e.g. ranging from 3.0-10.0 ppm) and conductivity (e.g. 100-1000 mmhos);

4) Food base consisting of base consisting of invertebrates (e.g. aquatic and terrestrial insects) and aquatic plants (e.g. diatoms and filamentous green algae);

5) Sufficient cover consisting of downed logs in the water channel, submerged aquatic vegetation, submerged large tree root wads, undercut banks with sufficient overhanging vegetation, large rocks and boulders with overhangs, a high degree of streambank stability, and a healthy, intact riparian vegetation community;

6) Habitat devoid of nonindigenous aquatic species detrimental to Gila chub or habitat in which detrimental nonindigenous species are kept at a level that allows Gila chub to continue to survive and reproduce; and

7) Streams that maintain a natural flow pattern including periodic flooding.

Gila chub last documented in Turkey Creek in New Mexico in 2001. In Arizona, small remnant populations remain in several tributaries of the upper Verde River, San Pedro River, San Carlos River, Blue River, San Francisco River, Agua Fria River, and the Gila River (Weedman et al. 1996, Desert Fishes Team 2003, 70 FR 66664).

In the Verde River basin, Walker and Spring creek populations (Yavapai County) are considered stable-threatened populations, and the status of the Williamson Valley Wash population was abundant in 2002 (Bagley 2002), but rare in 2003 (70 FR 66664). The SCR has three tributaries with extant populations of Gila chub: Sabino Canyon (Pima County) and Sheehy Spring (Santa Cruz County), which have unstable-threatened populations, and Cienega Creek (Pima and Santa Cruz Counties), which has the only known stable-secure population of Gila chub in existence. The San Pedro River basin has three extant, stable-threatened populations in Redfield Canyon (Graham and Pima counties), O'Donnell Creek (Santa Cruz County), and Bass Canyon (Graham and Cochise counties). The status of the Gila chub in the Babocomari River at T4 Spring (Santa Cruz and Cochise counties), is small and stable (Service files). The San Carlos and Blue rivers (Gila and Graham counties), on the San Carlos Apache Indian Reservation, are tributaries to the Gila River and they are believed to have extant populations of Gila chub. However, information is not available to us to confirm the status of Gila chub in those drainages (Weedman et al. 1996, Desert Fishes Team 2003, 70 FR 66664).

The San Francisco River has two tributaries with extant populations, Harden Cienega Creek and Dix Creek (Greenlee County). The status of these two populations is unknown, but both are thought to be small. The Agua Fria River has two tributaries with stable-threatened populations, Silver and Sycamore creeks (Yavapai County), as well as two unstable-threatened populations in

Little Sycamore Creek and Indian Creek (Yavapai County). In addition, there are two reestablished populations in the Agua Fria drainage, Larry Creek and Lousy Canyon (Yavapai County), for which the population status is unknown. Two tributaries of the Gila River in Arizona have extant populations of Gila chub. Eagle Creek (Graham and Greenlee counties), has an unstable threatened population and Bonita Creek (Graham County), has a stable-threatened population (Weedman et al. 1996, Desert Fishes Team 2003, 70 FR 66664).

In Mexico, the known distribution of Gila chub included two small spring areas at Rancho Los Fresnos, Cienega los Fresnos and Cienega la Cienegita, adjacent to the Arroyo los Fresnos (tributary to the San Pedro River), within 1 mi (2 km) of the Arizona-Mexico border (Varela-Romero et al. 1992) and the SCR. No Gila chub remain in the Mexican portion of the SCR (Weedman et al. 1996), and apparently not at Los Fresnos (Service files).

Reestablishment of Gila chub has been attempted in six Arizona sites; four are believed to be extant. Lousy Canyon and Larry Creek are tributaries to the Agua Fria River and were stocked with 200 Gila chub from Silver Creek in July 1995. The third site, Gardner Canyon (Cochise County), was stocked from Turkey Creek (Santa Cruz County) with 150 Gila chub in July 1988. In 1995, no Gila chub or any other fish were captured during surveys. Romero Canyon and Bear Canyon in the Santa Catalina Mountains were stocked with chub from Sabino Canyon in 2005. Bear Canyon has been reinfested with green sunfish, and chub may no longer occur there. Chub that were housed at the International Wildlife Museum in Tucson, originally from Turkey Creek (Babocomari River), were repatriated into Turkey Creek in 2006.

Threats to the species include predation by and competition with nonindigenous organisms, including fish in the family Centrarchidae and other fish species; disease; and habitat alteration, destruction, and fragmentation resulting from water diversions, dredging, recreation, roads, livestock grazing, changes in the natural flow pattern, mining, degraded water quality (including contaminants from mining activities and excessive sedimentation), and groundwater pumping (70 FR 66664). The impacts of nonindigenous species have been well documented (Hubbs 1955, Miller 1961, Minckley and Deacon 1968, Meffe 1985, Moyle 1986, Minckley and Deacon 1991, Ruppert et al. 1993). Dudley and Matter (2000) correlated green sunfish presence with Gila chub decline and found that even small green sunfish readily consume young-of-year Gila chub. Unmack et al. (2003) found that green sunfish presence was correlated with the absence of young-of-year Gila chub.

Riparian and aquatic communities across the Southwest have been degraded or destroyed by human activities (Hastings and Turner 1965, Hendrickson and Minckley 1984). Humans have affected southwestern riparian systems over a period of several hundred years. Eighty-five to ninety percent of the Gila chub's habitat has been degraded or destroyed, and much of it is unrecoverable.

No recovery plan has been completed, though a recovery outline has (Service files). The recovery outline provides a strategy for the recovery planning effort. It includes processes for developing both short-term emergency recovery actions to prevent further deterioration of the species' status, and longer-term planning for eventual recovery of the species. Development of

actions will occur in close coordination with both private and public partners, and with the help of the best experts on the species. We will involve Mexican partners in the planning process, including a representative of the La Comision de Ecologia y Desarollo Sustenable del Estado de Sonora (CEDES) in Hermosillo, Sonora, and other potential partners. Stakeholders will play a crucial role in plan development to ensure that recovery actions can be implemented effectively and in ways that minimize economic and social harm.

Chiricahua leopard frog (*Rana chiricuahuensis*)

The Chiricahua leopard frog was listed as a threatened species without critical habitat in 2002 (67 FR 40790). Included was a special rule to exempt operation and maintenance of livestock tanks on non-Federal lands from the section 9 take prohibitions of the Act. The Ramsey Canyon leopard frog (*R. subaquavocalis*) is similar in appearance to the Chiricahua leopard frog, but it may grow larger and has a call that is typically made under water (Platz 1993). Recent genetic work suggests *R. subaquavocalis* and *R. chiricahuensis* may be conspecific (Goldberg et al. 2004).

The Chiricahua leopard frog is an inhabitant of cienegas, pools, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,300 to 8,900 feet in central and southeastern Arizona; west-central and southwestern New Mexico; and in Mexico, in northern Sonora, and the Sierra Madre Occidental of northern and central Chihuahua (Platz and Mecham 1984, Degenhardt et al. 1996, Sredl et al. 1997, Sredl and Jennings 2005). The distribution of the species in Mexico is unclear due to limited survey work and the presence of closely related taxa (especially *R. lemosespinali*) in the southern part of the range of the Chiricahua leopard frog. In Arizona, slightly more than half of all known historical localities are natural lotic systems, a little less than half are stock tanks, and the remainder is lakes and reservoirs (Sredl et al. 1997). Sixty-three percent of populations extant in Arizona from 1993 to 1996 were in stock tanks (Sredl and Saylor 1998).

Based on Painter (2000) and the latest information for Arizona, the species is still extant in most major drainages in Arizona and New Mexico where it occurred historically, with the exception of the Little Colorado River drainage in Arizona and possibly the Yaqui drainage in New Mexico. It also has not been found recently in Arizona in: White River, West Clear Creek, Tonto Creek, Verde River mainstem, San Francisco River, San Carlos River, upper San Pedro River mainstem, SCR mainstem, Aravaipa Creek, Babocomari River mainstem, and Sonoita Creek mainstem. In southeastern Arizona, no recent records (1995 to the present) exist for the following mountain ranges or valleys: Pinaleno Mountains, Peloncillo Mountains, Sulphur Springs Valley, and Huachuca Mountains. Moreover, the species is now absent from all but one of the southeastern Arizona valley bottom cienega complexes. In many of these regions, Chiricahua leopard frogs were not found for a decade or more despite repeated surveys. Recent surveys suggest the species may have disappeared from some major drainages in New Mexico (C. Painter and R. Jennings, pers. comm., 2004).

Threats to this species include predation by nonindigenous organisms, especially bullfrogs, fish, and crayfish; disease; drought and climate change; floods; degradation and loss of habitat as a result of water diversions and groundwater pumping, poor livestock management, altered fire

regimes due to fire suppression and livestock grazing, mining, development, and other human activities; disruption of metapopulation dynamics; increased chance of extirpation or extinction resulting from small numbers of populations and individuals; and environmental contamination. Numerous studies indicate that declines and extirpations of Chiricahua leopard frogs are at least in part caused by predation and possibly competition by nonindigenous organisms, including fish in the family Centrarchidae (*Micropterus* spp., *Lepomis* spp.), bullfrogs, tiger salamanders, crayfish (*Orconectes virilis* and possibly others), and several other species of fish (Clarkson and Rorabaugh 1989; Sredl and Howland 1994; Rosen et al. 1995; Fernandez and Bagnara 1995; Snyder et al. 1996; Fernandez and Rosen 1996a and b, 1998). For instance, in the Chiricahua region of southeastern Arizona, Rosen et al. (1995) found that almost all perennial waters investigated that lacked introduced predatory vertebrates supported Chiricahua leopard frogs. All waters except three that supported introduced vertebrate predators lacked Chiricahua leopard frogs. Sredl and Howland (1994) noted that Chiricahua leopard frogs were nearly always absent from sites supporting bullfrogs and nonindigenous predatory fish. Rosen et al. (1995) suggested further study was needed to evaluate the effects of mosquitofish, trout, and catfish on frog presence.

A recovery plan has been completed (USFWS 2007), the goal of which is to improve the status of the species to the point that it no longer needs the protection of the Act. The recovery strategy calls for reducing threats to existing populations; maintaining, restoring, and creating habitat that will be managed in the long term; translocating frogs to establish, reestablish, or augment populations; building support for the recovery effort through outreach and education; monitoring; research needed to provide effective conservation and recovery; and application of research and monitoring through adaptive management. Recovery actions are recommended in each of eight recovery units throughout the range of the species. Management areas are identified within recovery units where the potential for successful recovery actions is greatest. Additional information about the Chiricahua leopard frog can be found in Platz and Mecham (1979, 1984), Sredl and Howland (1994), Rosen et al. (1995), Jennings (1995), Degenhardt et al. (1996), Sredl et al. (1997), Painter (2000), Sredl and Jennings (2005), and USFWS (2007).

ENVIRONMENTAL BASELINE

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions that are contemporaneous with the consultation process. The environmental baseline defines the status of the species and their habitats in the action area to provide a platform to assess the effects of the action now under consultation.

Action Area

The action area means all potential areas directly or indirectly affected by the Federal action and not merely the immediate area involved in the action. For nonindigenous species issues, the action area is often much larger than the area of the proposed project because of the tremendous and diverse ability of nonindigenous aquatic species to move and be moved throughout, and

colonize, large areas of the system. For the proposed project, the action area includes the entire extent of the Gila River basin, including the Santa Cruz subbasin. The action area includes the mainstem Gila River, the mainstem Hassayampa, Agua Fria, Verde, Santa Cruz, Salt, San Francisco, Blue, and San Pedro rivers, and all of their tributary streams in Arizona and New Mexico.

General Environmental Baseline

Please refer to the 1999 draft Santa Cruz BO (USFWS 1999b), the 2001 Gila BO and background document (USFWS 2001c, 2001d), and the 2002 Santa Cruz background document (USFWS 2002c) for the environmental baseline. Those documents are incorporated by reference.

Degradation of habitats is a well-recognized factor in establishment of nonindigenous species (Courtenay and Stauffer 1984, Soule 1990, Aquatic Nuisance Species Task Force 1994). According to AGFD records, at least 24 species of nonindigenous fish, two nonindigenous amphibians, and two nonindigenous invertebrates have been transported into the Santa Cruz subbasin (Tables 6 and 7). In addition, at least three other species of nonindigenous fish, two nonindigenous amphibians, one nonindigenous invertebrate, and many aquatic and riparian nonindigenous plants have been documented in the subbasin (AGFD unpub. data, Minckley 1973, Bequaert and Miller 1973, Hayes and Jennings 1986, Kerpez and Smith 1987, Lawson 1995, Rosen et al. 1995, Marsh 1997, Stromberg and Chew 1997, USGS 2001).

Status of the Species (within the Action Area)

Gila topminnow

The status of Gila topminnow within the action area is similar to its range-wide status since the Gila topminnow in the U.S. only occurs in the Gila basin. Only two natural populations are in the Gila basin, at the Bylas Springs complex on the San Carlos Apache Reservation. Nine are in the Santa Cruz subbasin. There are about 25 repatriated populations of Gila topminnow in the Gila River basin, though some may have failed (Voeltz and Bettaso 2003, Service files). Of those, two are contaminated with nonindigenous species. Other sites are likely to be stocked with Gila topminnow as part of the recovery effort over the 100-year life of CAP (Weedman 1999, Voeltz and Bettaso 2003). Many of the existing repatriated sites are in isolated waters that are never, or only extremely rarely, connected to other surface waters. However, some of them are connected intermittently to other surface waters. Some of those have artificial or natural barriers to upstream nonindigenous fish movement, while others rely solely on the intermittency of the downstream flow to prevent incursion by nonindigenous species.

Although the Santa Cruz subbasin contains the best of what remains of Gila topminnow natural populations, the status of the species in the subbasin is poor and declining. At least five populations of Gila topminnow in the Santa Cruz subbasin are known to have been lost since 1940, with the most recent occurring since 1987, and two others potentially lost in 2006. The only four (of 11) existing natural populations free of nonindigenous aquatic animals (Monkey

Table 6. Stocking records and survey results in the Santa Cruz River basin, Arizona, from AGFD data.

Species	Location species found	AGFD releases	Aquatic stocking permits
African clawed frogs	Tucson golf course	-	-
amur	-	-	Tucson
bass	-	-	Green Valley, multiple Tucson sites, Sasabe, Amado, Vail[1]
black crappie	Bog Hole, Patagonia Lake, Pena Blanca, Silverbell	Kennedy Lake	multiple Tucson sites, Pena Blanca[1]
blue catfish	-	-	Elgin, Tucson[1]
bluegill	Bog Hole, Redrock Canyon, Sonoita Creek below Patagonia Lake, Pena Blanca, Bear Grass, Arivaca, Fagan, Parker Canyon, Patagonia Lake, Silverbell, Kennedy, Lakeside	-	Sonoita, multiple Tucson sites, Green Valley, Vail, Amado, Catalina[1]
blue tilapia	-	-	Tumacacori, Tucson
brook trout	-	-	[1]
brown trout	Lemmon Creek	-	[1]
bullfrogs	San Rafael Valley, Santa Cruz River, Sonoita Creek	-	[1, 2]
bull minnow	-	-	[1]
bullhead	-	-	Tumacacori
catfish	-	-	Sonoita, multiple Tucson sites, Sahuarita, Green Valley, Amado, Vail[1]
channel catfish	Sonoita Creek below Patagonia Lake, Arivaca, Bear Grass, Bog Hole, Fagan, Parker Canyon, Patagonia Lake, Pena Blanca, Silverbell, Kennedy, Lakeside	Pena Blanca, Fagan Tank, Arivaca, Parker Canyon, Bear Grass Tank, Randolph Park	multiple Tucson sites, Marana, Sonoita, Green Valley, Sasabe, Arivaca, Red Rock, Sells, Vail, Catalina
common carp	Silverbell, Kennedy, Lakeside	-	[1]
crappie	-	-	Tucson[1]
crayfish	-	-	Tucson
fathead minnow	Fresno Canyon, Santa Cruz @ gage, Sharp Spring, Sonoita Creek below Fresno Canyon	Pena Blanca	Avra Valley Material Pit, multiple Tucson sites, Sonoita, Green Valley
flathead catfish	Sonoita Creek below Patagonia Lake, Patagonia Lake	Fagan Tank	-
golden shiner	-	-	[1]
goldfish	Little Outfit Tank, Rincon, Kennedy	-	Green Valley, multiple Tucson sites[1]
grass carp	Kennedy	-	-
green sunfish	Bog Hole, Fresno Canyon, Romero Canyon, Sabino Canyon, Santa Cruz @ gage, Sharp Springs, Sonoita Creek below Patagonia Lake, Sonoita Creek @TNC, Arivaca, Bear Grass, Fagan, Kennedy, Parker Canyon, Patagonia Lake, Pena Blanca, Silverbell, Lakeside	Arivaca Lake	Pena Blanca[1]
largemouth bass	Alambre Tank, Bog Hole, Fagan Tank, Fresno Canyon, Redrock Canyon, Bear Grass Tank, Sabino Canyon, Santa Cruz @ gage, Sonoita	Fagan Tank, Bear Grass Tank, Arivaca Lake, Randolph	multiple Tucson sites, Marana, Sonoita, Green Valley, Rio

Table 6. Stocking records and survey results in the Santa Cruz River basin, Arizona, from AGFD data.

Species	Location species found	AGFD releases	Aquatic stocking permits
	Creek below Fresno Canyon, Sonoita Creek below Patagonia Lake, Sonoita Creek @TNC, Patagonia Lake, Parker Canyon, Arivaca, Pena Blanca, Silverbell, Fagan, Lakeside, Kennedy	Park	Rico, Catalina
minnow	-	-	Sasabe, multiple Tucson sites, Green Valley[1]
mosquitofish	Alambre Tank, Bog Hole, Santa Cruz @ gage & @ Rio Rico, Fresno Canyon, Redrock Canyon, Sonoita Creek @TNC, Sabino Canyon, Sheehy Spring, Sharp Spring, Sonoita Creek below Fresno Canyon, Sonoita Creek below Patagonia Lake, Kennedy, Silverbell, Lakeside	-	CAP, multiple Tucson sites, Vail[1]
northern pike	Parker Canyon Lake	-	-
ornamental carp	-	-	Tucson
pacu	-	-	multiple Tucson sites
piranha	-	-	Tucson
prawn, freshwater	-	-	Tucson
rainbow trout	Parker Canyon, Patagonia, Pena Blanca, Rose Canyon, Kennedy, Silverbell, Lakeside	Pena Blanca, Rose Canyon, Patagonia, Parker Canyon	multiple Tucson sites Green Valley[1, 2]
red shiner	Fresno Canyon, Sonoita Creek below Fresno Canyon, Sonoita Creek below Patagonia Lake, Sonoita Creek @TNC	-	-
redear sunfish	Arivaca, Bear Grass Tank, Bog Hole, Fagan Tank, Parker Canyon, Patagonia Lake, Pena Blanca, Kennedy, Silverbell, Lakeside	Fagan Tank, Arivaca Lake, Kennedy Lake	multiple Tucson sites[1]
rock bass	-	-	Tucson
shortnose gar	-	-	-
sunfish	-	-	multiple Tucson sites[1]
threadfin shad	Kennedy, Lakeside, Silverbell, Patagonia Lake	-	-
redbelly tilapia	-	-	multiple Tucson sites, Oro Valley, Silver Bell[1]
Mozambique tilapia	-	-	multiple Tucson sites, Marana
tilapia	-	Randolph Park	[1]
waterdogs[4]	San Rafael Valley	-	Tucson
white amur	-	-	[1]
yellow bullhead	Sonoita Creek below Fresno Canyon	-	Tucson

[1] private sites include aquaculture facilities, gravel pits, golf course ponds, subdivision ponds, public park ponds, private ponds, fish tanks and aquariums, stock ponds

[2] also stocked at sites in southeastern Arizona outside the Santa Cruz River basin

[3] includes those listed as "trout"

[4] subspecies *Ambystoma tigrinum mavortium*, which are hybridizing with the Sonora tiger salamander (*A. t. stebbensi*)

TABLE 7. Nonindigenous species found historically in selected southern Arizona waters, and releases by AGFD (AGFD data).

Species	Arivaca Lake	Bear Grass Tank	Bog Hole Tank	Fagan Tank	Kennedy Park	Parker Canyon Lake	Patagonia Lake	Pena Blanca Lake	Silverbell	Rose Canyon Lake	Lakeside Park
green sunfish	Y++[1]	0	N++	N++	N++	N++	N++	N++[2]	N++	N++	N++
black bullhead	C[1]	---	---	---	---	N++	---	N++[2]	---	---	---
channel catfish	Y++	N++	N++	Y++	Y++	Y++	N++	Y++[2]	Y++	---	Y++
common carp	C	C	C	C	N++	C	C	C	N++	C	N++
goldfish	C	C	C	C	N++	C	C	C	C	C	---
piranha	C	C	C	C	N++	C	C	C	C	C	---
threadfin shad	C	C	C	C	N++	C	N++	--	N++	C	N++
mosquitofish	N++	N++	N++	N++	N++	N++	N++	N++	N++	C	N++
grass carp	C	C	C	C	Y++[3]	C	C	C	Y++[3]	C	---
bluegill sunfish	N++	N++	N++	N++	N++	N++	N++	N++[2]	N++	C	N++
redear sunfish	Y++	N++	N++	Y++	N++	N++	N++	N++	N++	C	---
largemouth bass	Y++	Y++	Y++	Y++	Y++	Y++	Y++	Y++[2]	Y++	---	Y++
rainbow trout	C	C	C	C	Y++	Y++	Y++	Y++	Y++	Y++	Y++
fathead minnow	C	C	C	C	C	C	C	YB[1]	---1	C	---
flathead catfish	C	C		YB	C	C	N++	C	C	C	---
black crappie	C	C	N++	C	Y++	C	N++	N++[2]	N++	C	---
tilapia	C		C	C		C	C	C	Y--	C	---

[1] Y++ = found during surveys and stocked by AGFD N++ = found during surveys and no AGFD stocking records
YB = stocked but not found during surveys C = not found during surveys
[2] AGFD aquatic stocking permit to Pena Blanca Lodge for black crappie, green sunfish, largemouth bass, black bullhead, channel catfish, bluegill
[3] stocked by the City of Tucson

Spring, Cottonwood Springs, Fresno Canyon, and Cienega Creek) are in the Santa Cruz subbasin. The other five in the subbasin are contaminated with varying species and levels of nonindigenous species. Numerous other threats exist to all of the populations. Stocked populations of Gila topminnow have not been successful within the subbasin, with only two reestablished populations remaining.

Cienega Creek

The Cienega Creek Gila topminnow natural population on Las Cienegas National Conservation Area is one of only two on public lands and it is by far the largest of all the remaining natural populations (Simms and Simms 1991). There is also a perennial section of Cienega Creek north (downstream) of Interstate 10 that holds topminnow.

Gila topminnow was first documented from Cienega Creek in the 1970's. In addition to Gila topminnow, Cienega Creek supports two other native fishes (Bagley et al. 1991, Simms and Simms 1991), the longfin dace and the endangered Gila chub. Cienega Creek is one of the last places in Arizona supporting an intact native fish fauna uncontaminated by nonindigenous fish and is one of only four natural Gila topminnow populations not contaminated by mosquitofish (Weedman 1999). No nonindigenous fish and few other nonindigenous taxa are found in Cienega Creek. With increasing access and recreational use, the vulnerability of the stream and its Gila topminnow population to nonindigenous invasion is intensifying. The Cienega Creek basin has been closed to fishing by the Arizona Game and Fish Commission to lessen the potential for release of illegal fish and live bait.

In October 2001, Gila topminnow was repatriated into the Cienega Creek drainage at Empire Gulch, within the National Conservation Area. Additional releases of topminnow have been made. Gila topminnow has not established a robust population at Empire Gulch, probably because of high levels of aquatic vegetation and aquatic invertebrate predators.

Cienega Creek and its Gila topminnow habitat are subject to a number of human uses, including livestock grazing, recreation, urban and suburban development, groundwater pumping, and roads. Before BLM acquired the area, it was primarily used for grazing, but there were also extensive agricultural fields along the creek (Eddy and Cooley 1983). These fields were irrigated by a system of canals and dams that locally destroyed Gila topminnow habitat and created severe erosion. The BLM is removing these developments and has reconstructed part of the creek to restore more natural geomorphic and hydrologic conditions (USFWS 1998a, Simms 2001). The National Conservation Area presently receives heavy human visitation, and most of the stream is readily accessible. Recreational use will likely increase with the population growth in southern Arizona. Above BLM land, the valley is mostly used for livestock grazing. However, there is extensive proliferation of ranchette development in the area surrounding the town of Sonoita, which is itself growing. This growth is based on groundwater use, which could threaten the surface water of Cienega Creek. Several wineries and vineyards occur along the groundwater divide between the Cienega Creek and Babocomari River basins. The vineyards are entirely supported by groundwater.

There are potentially serious erosion problems, and recreation and other uses are increasing, creating threats to habitat quality and raising the potential for other nonindigenous invasions. Management changes to improve riparian and aquatic habitat, coupled with drought, have actually caused topminnow to become significantly rarer in the upper perennial reach. The lower reach appears to have a stable Gila topminnow population, but because of how data were collected, even that is uncertain (G. Bodner, TNC, pers. comm., 2007; J. Simms, BLM, pers. comm., 2007). The Cienega Creek topminnow population is still considered a viable population, and it is still the largest by far in the U.S.

The Cienega Creek Preserve is owned by the Pima County Flood Control District and managed by Pima County Natural Resources, Parks, and Recreation. Gila topminnow was discovered on Pima County's Preserve in 2002, as was Gila chub. Gila topminnow are numerous below the headcut (Service files). Gila chub may be extirpated there due to loss of pool habitat during flooding, headcut migration, and excessive sedimentation. Longfin dace also occur there. Use of the Preserve is limited to recreation, which is limited to 20 people per day. The area is being developed, and the area between the upper perennial section on the NCA and the preserve is being planned for development. Several clay pits, sand and gravel mines, and other mineral development occurs or is planned in the area. Some of the clay pits close to the preserve have been known to contain water and nonindigenous fish and bullfrogs. Fortunately, to date no nonindigenous fish have been found in Cienega Creek in the Preserve. There is a diversion at the downstream-most end of perennial flow. All base flow is diverted down a grated pipe.

Sonoita Creek

Sonoita Creek is a major tributary of the SCR, joining it near the town of Rio Rico in Santa Cruz County. Perennial surface flow is present in the area of Cottonwood Spring (considered separately below), and from below the town of Patagonia, where it is augmented by sewage return flows, to about 1 mile (2 km) above the confluence with the SCR. Patagonia Lake is located in the lower half of the drainage and is a moderate sized recreational reservoir, which impounds Sonoita Creek. Much of Sonoita Creek is privately owned, although Patagonia Lake is owned by the State and a portion of the stream below the lake is part of the Sonoita Creek State Natural Area.

Gila topminnow was first documented from Sonoita Creek in 1904 near the town of Patagonia (Chamberlain 1904). Gila topminnow are particularly rare above Patagonia Lake (H. Blasius, AGFD, pers. comm., November 2001; Service files; Voeltz and Bettaso 2003), but are more numerous below the lake (Voeltz and Bettaso 2003; Service files). Above Patagonia Lake, numbers and distribution of nonindigenous fish are increasing (H. Blasius, AGFD, pers. comm., November 2001). There are also a number of nonindigenous riparian and aquatic plants present in Sonoita Creek (USFWS files). Although within the stream native fish species are more numerous than nonindigenous fish, Patagonia Lake serves as a continual source of nonindigenous species, as may be the many stock tanks in the watershed. Live bait use of threadfin shad (*Dorosoma petenense*) and all varieties of sunfish is allowed at Patagonia Lake. Crayfish have moved upstream from the lake, at least to TNCs Patagonia Preserve (Service files).

Sonoita Creek contains a tenuous natural population of Gila topminnow above Patagonia Lake and a slightly more robust one below (Minckley et al. 1977, Young and Lopez 1995, Voeltz and Bettaso 2003, USFWS and AGFD unpub. data). Additional populations are found in its tributaries Redrock Canyon, Fresno Canyon, Coal Mine Canyon, Cottonwood Spring, and Monkey Spring (Rinne et al. 1980, Simons 1987, Stefferud and Stefferud 1994, Voeltz and Bettaso 2003). Only Cottonwood and Monkey Spring, and Fresno Canyon (including Coalmine Canyon) are uncontaminated with nonindigenous aquatic fish. Only Redrock Canyon is on federally owned land, although parts of Sonoita Creek, Fresno Canyon, and Coal Mine Canyon are on State Park land. Recent acquisitions have placed Coal Mine Spring and Canyon under AGFD ownership. Threats to these populations come from burgeoning subdivision and ranchette development, nonindigenous aquatic species, groundwater pumping, water pollution, livestock grazing, recreation, roads, and mining. Several surveys in 2006 in the Redrock Canyon drainage have failed to find Gila topminnow, probably due to the synergistic effect of drought and mosquitofish (USFWS and AGFD unpub. data).

Cottonwood Spring

Cottonwood Spring is a tributary of Sonoita Creek. The spring issues from a hillside along the Sonoita Creek valley bottom and runs about 100 ft (30 m) before it is captured in a pipe, which transports water downstream to irrigate nearby fields. Some water seeps from and overflows the spring to contribute to Sonoita Creek. Cottonwood Spring is located on privately owned land, and is the site of two past Service Partners for Wildlife projects. Because of these projects, grazing was excluded from the spring and riparian area, and two small headcut control gabions were built below the perennial flow to control upstream movement of erosion. Reclamation has modified the downstream headcut control gabion to function as a fish barrier below the perennial flow.

Gila topminnow were first collected in Cottonwood Spring in 1938 (Univ. of Michigan Mus. of Zool. [UMMZ] No. 125052). Two other rare species, Huachuca springsnail (*Pyrgulopsis thompsoni*) (Hershler and Landye 1988) and Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) also occur there, and it is designated critical habitat for the umbel. There are stock tanks upstream in Hog Canyon, Fort Canyon, and the Sonoita area, which may contain nonindigenous species. El Pilar Tank, in upper Adobe Canyon, a tributary of Sonoita Creek about 0.6 mi (1 km) below Cottonwood Spring, is an extirpated Gila topminnow reestablishment site where goldfish were found in 1994 (Weedman and Young 1997). Although the area around Cottonwood Spring and Sonoita Creek is privately owned and posted against trespassing, it is easily accessible and therefore, vulnerable to bait-bucket movement of nonindigenous species.

Monkey Spring

Monkey Spring is located 1.2 mi (2 km) south of Cottonwood Spring and several hundred feet east of Sonoita Creek. It originates on a sideslope above Monkey Canyon, a tributary of Sonoita Creek. Before diversion, the spring flowed through a marsh then over a travertine terrace that resulted in a waterfall of about 40 ft (12 m) into the canyon (Minckley 1973). In the late 1800's a dam was built across the terrace and the flow diverted into a ditch (see also Chamberlain 1904). The artificial pond later drained when attempts to deepen it resulted in breaking the seal on the

bottom. The springhead and a short reach are excluded from livestock grazing. The spring continues to be diverted into a ditch that takes it to the Sonoita Valley for irrigation purposes. Some flow periodically drains into the pond and provides transient Gila topminnow habitat.

Monkey Spring is privately owned and is not accessible to the public. The ranch on which it is located is now being subdivided. Although the portion containing Monkey Spring is not part of the present subdivision, its future is not secure, and reportedly part of the water rights have been sold. Additional water use to support development may affect Monkey Spring and Sonoita Creek.

Gila topminnow was first documented in Monkey Spring in 1904 (Chamberlain). Monkey Spring is the most genetically differentiated of the Gila topminnow populations (Hedrick and Parker 1998, Hedrick et al. 2001, Parker et al. 1999) in the Gila basin. Historically, two other native fish occurred in Monkey Spring, the Santa Cruz pupfish (*Cyprinodon arcuatus*) and Gila chub (Minckley 1973). The pupfish went extinct, and Gila chub was extirpated after nonindigenous sport fish were introduced (Minckley 1973). Yaqui catfish, a native of the Rio Yaqui basin to the east and south, were introduced into a reservoir fed by Monkey Springs in 1899, but died out sometime after 1950 (Chamberlain 1904, Minckley 1973). At present, there are no nonindigenous fish in Monkey Spring (Voeltz and Bettaso 2003). Previous landowners introduced the nonindigenous fish in the past, and this remains a possibility.

Redrock Canyon

Redrock Canyon is also a tributary of Sonoita Creek, entering Sonoita Creek at the town of Patagonia. Redrock Canyon is a wide, relatively complex drainage lying between the Canelo Hills to the north and the Patagonia Mountains to the south. Although a large cienega was historically located at the confluence of Redrock Canyon and Sonoita Creek (Hendrickson and Minckley 1984, Davis 1986), that cienega is gone and present surface flow in Redrock Canyon is perennial interrupted, with flow present in most parts of the canyon only during precipitation. There are several perennial springs in the drainage (Stefferud 1989, Stefferud and Stefferud 1994, 2001). Primary areas of perennial flow are located in Cott Tank drainage and Redrock Canyon at its confluence with Cott Tank drainage, at Gate Spring, at the Falls area, and about 0.75 mi (1.2 km) upstream from the Forest boundary. With the exception of one 160-acre (64 ha) inholding, all of Redrock Canyon is on the Coronado National Forest.

Much of the perennial, flowing water is excluded from livestock use, although there has been periodic livestock use due to fence failures. As exclosed areas recovered from livestock impacts, one of the exclosure fences was extended. However, drought the last few years has caused a severe diminution in flow.

Mosquitofish are especially numerous and vary from rare at the downstream areas to abundant in Cott Tank drainage, where they have averaged 38% of the topminnow/mosquitofish present since 1991 (Stefferud and Stefferud 1994 and unpub. data, Weedman and Young 1997). Habitat complexity and periodic flooding may have allowed the historical coexistence of mosquitofish and Gila topminnow at this site. Recent surveys have not found Gila topminnow. The synergistic combination of drought and mosquitofish appears to have extirpated the population.

Plans are being made to install a fish barrier, remove nonindigenous fish, and repatriate native fish.

Fresno, Coal Mine, and Ash Canyons

Fresno Canyon is a stream that enters Sonoita Creek several miles below Patagonia Lake. Much of Fresno Canyon is within the Sonoita Creek State Natural Area, but the upper watershed is on private land. Fresno Canyon contains perennial water and fish only in a couple of stretches. Coal Mine Canyon is mostly on land owned by the AGFD and managed by the State Natural Area, and partly on private land. Trespass grazing is the primary human activity affecting Gila topminnow. Fencing to exclude cattle is ongoing. On private lands, livestock grazing is also the primary human activity. There are stock tanks on the private land that may be the source of much of the nonindigenous fish population of Fresno and Coal Mine canyons. Occupation of these stock tanks by nonindigenous species is difficult to control; renovation is possible, but subject to landowner approval. Recreation is minimal because the area is difficult to access. Parts of the upper watershed are for sale and are being converted from grazing lands to low density housing.

Gila topminnow was not discovered in Fresno Canyon until 1992 and in Coal Mine Canyon until 1996 (Weedman and Young 1997). Gila topminnow and nonindigenous green sunfish were always found during surveys and may be coexisting here. Gila topminnow tended to be found in microhabitats (e.g. pool margins) that were unavailable to adult green sunfish. Fresno Canyon on the State Natural Area was renovated, apparently successfully (Service files), for removal of green sunfish in 2007.

The Ash Canyon location was discovered in 2005, and subsequently found dry five months later in 2006. Ash Canyon flows into Patagonia Lake. George Wise Spring is in Ash Canyon, below the topminnow location, and is infested with green sunfish, bass, and crayfish. Small pockets of water have been found in Ash Canyon above the topminnow site, but none has contained fish.

Santa Cruz River

Gila topminnow is present in several areas of the SCR. However, some of those areas are located in Mexico and, because the species is listed only in the United States, those areas are not legally considered endangered although their biological status does not differ from the SCR populations in the United States. The river in Mexico has interrupted perennial flow. Perennial flow resumes downstream from the Nogales International Wastewater Treatment Plant, near the mouth of Sonoita Creek, and continues to around Tubac. Gila topminnow is present in this stretch. It also is the only population that mixes two different Gila topminnow stocks (Santa Cruz in Mexico and lower Sonoita Creek complex) (Hedrick et al. 2001). This population is unique in that it is the only remnant of the species occupying what was originally the primary Gila topminnow habitat in the mid-reaches of one of the larger Gila basin rivers. Downstream from Tubac, no perennial flow is present until sewage effluent from Tucson enters the river. Gila topminnow is not known from this effluent reach in Tucson.

The upper Santa Cruz in the San Rafael Valley has interrupted perennial surface water, although short periods of no flow occur most years. Areas in private ownership are used for livestock grazing and irrigated agriculture. A large earthen tank to store irrigation water is located near the mouth of Sheehy Spring, and ditches to carry water to the fields are present in the floodplain.

The first topminnow record in the San Rafael Valley is from 1940 (UMMZ No. 118419-118422). The last topminnow found in this section was in 1993 (Weedman and Young 1997), however, annual sampling is usually limited to only a very short stretch of the river, and the survey is insufficient to determine the presence or absence of the species in the river. This area supports numerous nonindigenous species. Recent, more extensive surveys of the SCR in the San Rafael Valley have only documented mosquitofish and green sunfish (Service files).

The natural populations of Gila topminnow in the San Rafael Valley, if still present, are now on State Parks lands, one is on private lands, on which State Parks holds a conservation easement, and the owner is conservation-minded. Increased recreational use of the area and river is likely under State Parks management, though the Natural Area remains closed to the public pending initiation and completion of a management plan. Gila topminnow was recorded in the river in Mexico in 2006 (Service files) but has not been collected in the United States portion since 1993 (Weedman and Young 1997). This portion of the river has been impacted by watershed degradation and ongoing agriculture and livestock grazing, although the private landowner has limited grazing in the riparian corridor (R. Humphreys, pers. comm., 2000; pers. obs.).

The middle Santa Cruz is that portion of the river from where it reenters the United States to where it historically dried near Continental, in Santa Cruz and Pima counties. Almost all of the flood plain in this reach of the river is privately owned, with multiple landowners. There are many access points with several river crossings, parallel roads, multiple dwellings, and urban and industrial development. Impacts and threats to this reach of the river include contaminants, nonindigenous species, water withdrawals, and urbanization. Besides excessive ammonia levels and heavy metals issuing from the water treatment plant (King et al. 1999), contaminants and trash from runoff and untreated sewage from Mexico make it into the mainstem in Mexico, and into Nogales Wash and Potrero Creek. The amount of water released from the treatment plant should remain stable in the near future. Planned upgrades to the treatment plant should reduce the amount of ammonia released into the river. Continuing development in the valley could lead to localized groundwater depletion.

Topminnow was rediscovered in this reach near Rio Rico in 1994 (Weedman and Young 1997). They still occur today in most of the perennial portion of the river that is below the Nogales International Wastewater Treatment Plant, though their geographic extent and numbers fluctuate widely (Voeltz and Bettaso 2003). The upper portions of this reach are not habitable to fish because of high ammonia levels. Although nonindigenous species, including mosquitofish, have been found in this reach, recent surveys have found few (crayfish in 1997 [Kirke King, USFWS, pers. comm. 1998]) or no nonindigenous species (Weedman and Young 1997, Voeltz and Bettaso 2003). Nonindigenous species also occur upstream in Mexico and the upper SCR, in Sonoita Creek and Patagonia Lake, and in stock tanks in the watershed.

This population of Gila topminnow exists in the SCR from Rio Rico to Tubac. Groundwater pumping caused the loss of perennial flow in this area, and flow is now entirely supported by waste water from the Nogales International Waste Water Treatment Plant. This topminnow population is contaminated with nonindigenous fish and invertebrates and affected by urban and suburban development. In its uppermost reach, below the Nogales International Water Treatment Plant, high ammonia levels and other contaminants (King et al. 1999) apparently affect it. The only recent surveys have been at Tumacacori National Historic Park (2005), where only longfin dace was found (USFWS and AGFD unpub. data).

The lower SCR from Tucson downstream only contains perennial flow below two wastewater treatment plants in Tucson. Historically, this reach was perennial. Gila topminnow were first recorded in this reach in 1853 (Baird and Girard) and were last recorded in 1943 (UMMZ No. 1466671). The Tucson basin and the Santa Cruz, Rillito, and Pantano drainages historically provided extensive fish habitat (Davis 1982) in what are now ephemeral, highly modified, and constrained channels. The slow-moving, cienega type habitat found in these drainages in the past would have been ideal topminnow habitat. Most natural aquatic habitats are gone from the Tucson basin.

Sharp and Sheehy Springs

Sharp and Sheehy springs are tributary to the upper SCR in the San Rafael Valley, as is Heron Spring, one of only two surviving stocked populations of Gila topminnow in the Santa Cruz subbasin (Voeltz and Bettaso 2003). Sharp Spring is a tributary of the upper SCR near Lochiel in Santa Cruz County. The spring is located about 1 mi (1.5 km) up a small drainage from the river, and hydrological connection with the river occurs only during periodic flooding. The spring is actually a cienega system made up of a series of deep, narrow pools with flow between them through thickly vegetated shallows or in very narrow deep channels. Recent drought has caused the upper pools to dry or become anoxic, and flow between the pools is often nonexistent. Land uses and status are the same as that described above for the upper SCR in the San Rafael Valley. Despite historical livestock grazing before 1999, Sharp Spring is only lightly impacted, and the riparian vegetation and cienega structure are well developed. It is not currently grazed. However, it is located near the road and has experienced use by undocumented aliens. This use is expected to continue with subsequent adverse effects to the system and the fish. Recreational use is expected to occur once the San Rafael State Natural Area is open to the public.

The first fish occurrence records at Sharp Spring are from 1979 (Meffe et al. 1982). At that time, mosquitofish were already in the system. By the late 1980's and early 1990's, mosquitofish comprised 77 to 99 percent of the fish present and were found throughout the entire system. In 1999, of almost 1,600 poeciliids captured, only two percent were topminnow. In 2004, only 1 of 398 Poeciliids was a topminnow, the last year Gila topminnow were captured (Service files). The habitat complexity and periodic flooding may have allowed minimal coexistence of the two species (Meffe et al. 1982, Meffe 1984, 1985) with mosquitofish eventually extirpating topminnow. The balance probably tipped after 1999 with lack of flooding, and with drought reducing the amount of available habitat.

Located about a mile upstream from Sharp Spring, the Gila topminnow population in Sheehy Spring is probably extirpated. Sheehy Spring is located in a small drainage just off the SCR. It is a smaller system than Sharp Spring, consisting of a marshy upper area, a pool-run middle section, an impounded pool, and a long run through a marshy area along the edge of the Santa Cruz floodplain. Its ownership and status are the same as described for the upper SCR in the San Rafael Valley.

Topminnow was discovered in Sheehy Spring in 1939 (UMMZ No. 131105). They were last seen in 1987 (Bagley et al. 1991). In 1977, only Gila topminnow and Gila chub were present in the upper part of Sheehy Spring, although mosquitofish were abundant in the lower part (Johnson 1977, Minckley et al. 1977). The next survey, in 1979, found that mosquitofish made up 42 percent of the poeciliids (Meffe et al. 1983). The very next year, mosquitofish comprised 94 percent of the poeciliids captured (Meffe and Hendrickson 1980, Meffe et al. 1983). Mosquitofish outnumbered Gila topminnow about 9 to 1 until 1988, when no topminnow were found (Bagley et al. 1991). No topminnow have been found since despite extensive sampling (Service files, Weedman and Young 1997, Voeltz and Bettaso 2003). Although the Gila topminnow have not been found at Sheehy Spring since 1987, presumably due to mosquitofish contamination, it is considered a high priority site for nonindigenous species removal and restocking with Gila topminnow (Weedman 1999, Voeltz and Bettaso 2003). Gila chub and mosquitofish still occur at Sheehy Spring, though mosquitofish were not found during two quick surveys in 2005 (Service files).

Heron Spring

Heron Spring is located in a small tributary of the upper SCR in the San Rafael Valley. It is about 0.5 mi (0.75 km) south of Sharp Spring and consists of a small pool at the base of a large headcut and about 0.25 mi (0.4 km) of marshy flow. In the past, the spring has received heavy use by livestock, but human access was restricted by private ownership, which has probably contributed to keeping this site free of nonindigenous species. The site is not visible from the road and may not receive extensive recreation now that the area is in State Parks ownership and may eventually be open to the public.

In 1981, Heron Spring was stocked with Gila topminnow from Sharp Spring (Simons 1987). No other fish species occur here. Although the drainage is tributary to the SCR, upward movement of fish is blocked by a stock tank low in the drainage. Heron Spring is free of nonindigenous fish, but has a very small topminnow population. Heron Spring is one of two reestablishment sites for Gila topminnow that are still extant in the SCR subbasin, though a survey in 2007 failed to find any fish (AGFD and Service files).

Razorback sucker

Like desert pupfish, razorback sucker was extirpated from the Gila River basin and exists there now only as repatriated populations. There are no records of razorback sucker from the SCR subbasin. The primary stocking efforts are in the Salt and Verde rivers, but razorback sucker have also been stocked into the Gila, Black, Blue, East Verde, and San Francisco rivers and Cherry, Coon, Canyon, Carrizo, Cedar, Tonto, Fossil, Oak, West Clear, Beaver, Sycamore,

Eagle, and Bonita creeks (Hendrickson 1993). Survival of these stocked individuals has been very low, and no reproduction has yet been documented (AGFD 1998). Future stocking efforts are expected to focus on the Salt and Verde rivers but may be expanded to include other areas. The status of the species within the action area is very precarious, since no reproduction from stocked individuals has been documented.

Designated critical habitat in the action area consists of the following river reaches in the action area and their associated 100-year floodplain (59 FR 10898):

- the Gila River from New Mexico to Coolidge Dam including San Carlos Reservoir to its full-pool elevation;
- the Salt River from the Highway 60 bridge to Roosevelt Diversion Dam; and
- the Verde River from the Prescott National Forest boundary to Horseshoe Dam including Horseshoe Lake to its full-pool elevation.

At the time of designation of critical habitat, all river reaches and floodplains occupied by the species had been extensively modified by past human activities. These activities had significantly affected the water, physical habitat, and biological habitat constituent elements of the designated reaches. Those alterations, as well as how each reach related to the constituent elements were discussed in the biological support document (USFWS 1993a) for each designated reach. All designated areas are considered essential for the conservation of the species, with the recognition that not all areas to be designated met all the essential features of critical habitat. These areas require special management or other actions to ensure their value to the species conservation was not compromised. As section 7 consultations on proposed Federal actions have been completed with regard to critical habitat, the environmental baselines were updated to reflect the results of those consultations.

Spikedace and loach minnow

The status of spikedace and loach minnow within the action area is identical to their range-wide status, as both species are endemic to the Gila River basin. Neither species were found in the SCR subbasin. The population of spikedace in the middle Gila River, and the populations of spikedace and loach minnow in Aravaipa Creek and their final critical habitat (72 FR 13356) in the San Pedro River basin are within the areas most likely to be invaded by nonindigenous aquatic species introduced or spread via CAP. Populations and critical habitats in the upper Verde, Gila, San Francisco, Blue, Eagle Creek, and Black drainages are upstream of one or more mainstem dams from the aqueduct. Over the 100-year life of the project, repatriation of spikedace and loach minnow is expected to occur in areas throughout the Gila basin. The likelihood of direct and indirect effects from CAP-mediated nonindigenous species varies greatly among those areas. The status of spikedace and loach minnow within the action area is poor and declining with nonindigenous aquatic species being one of the major factors. Nonindigenous species pressures in some areas, such as the upper Verde River, may already be at levels lethal to spikedace and loach minnow survival, and no increases can be tolerated.

In Arizona, loach minnow critical habitat includes portions of the Black River, East Fork Black River, North Fork East Fork Black River, and Boneyard Creek; Aravaipa Creek and its

tributaries Deer and Turkey creeks; the San Francisco River, Eagle Creek, and the Blue River and its tributaries, Campbell Blue Creek and Little Blue Creek. In New Mexico, the current designation includes portions of the Blue River; the San Francisco River and its tributary Whitewater Creek; the Tularosa River and its tributary, Negrito Creek; Campbell Blue Creek; Dry Blue Creek and its tributaries Frieborn and Pace creeks; and the Gila River, including portions of its West, Middle, and East forks.

Spikedace critical habitat in the action area includes portions of the Verde River, the middle Gila River, the upper San Pedro River, and Aravaipa Creek in Arizona, and portions of the upper Gila River and its West, Middle and East Forks in New Mexico.

Gila chub

The status of the Gila chub within the action area is identical to its range-wide status (70 FR 66664). We designated about 160.3 mi (258.1 km) of stream reaches as critical habitat (70 FR 66664). Critical habitat includes the area of bankfull width plus 300 ft (91m) on either side of the banks. We designated critical habitat in seven areas, all within the action area:

Upper Gila River (Grant County, New Mexico, and Greenlee County, Arizona): Turkey Creek, Eagle Creek and East Eagle Creek, Harden Cienega Creek, and Dix Creek including the Left Prong of Dix Creek upstream of its confluence with Dix;

Middle Gila River (Pinal County, Arizona): Mineral Creek;

Babocomari River (Santa Cruz County, Arizona): O'Donnell Canyon, and Turkey Creek;

Lower San Pedro River (Cochise and Graham counties, Arizona): Bass Canyon, Hot Springs Canyon, and Redfield Canyon;

Lower Santa Cruz River (Pima County, Arizona): Cienega Creek, Mattie Canyon, Empire Gulch, and Sabino Canyon;

Upper Verde River (Yavapai County, Arizona): Walker Creek, Red Tank Draw, Spring Creek, and Williamson Valley Wash; and

Agua Fria River (Yavapai County, Arizona): Little Sycamore Creek, Sycamore Creek, Indian Creek, Silver Creek, Lousy Canyon, and Larry Creek.

Chiricahua leopard frog

In the action area in Arizona, the species is extant in the Salt, Verde, Gila, San Pedro, Santa Cruz, river drainages. Within the extant drainages, the species was not found recently in some major tributaries or from river mainstems. Recent surveys suggest the species may be extirpated from the Chiricahua and Galiuro mountains, as well. The Chiricahua leopard frog is known or suspected to have been historically present, and at least in some cases, very abundant (Wright and Wright 1949) in each major southeastern Arizona valley bottom cienega complex. It is

thought to be breeding in small numbers in Empire Gulch, but is absent as a breeding species from all others, including Arivaca Cienega, upper Santa Cruz Valley cienegas, Babocomari Cienega, marshy bottoms of the upper San Pedro River, and San Simon Cienega. A small breeding population exists at O'Donnell Creek and cienega, but recruitment to the population appears to be limited due to predation by nonindigenous crayfish, and long-term viability of the population may depend on immigrants Rosen et al. 2002; E. Wallace, pers. comm. 2004). These large, valley bottom cienega complexes may have supported the largest populations in southeastern Arizona, but are now so overrun with nonindigenous predators that they do not presently support the Chiricahua leopard frog in viable numbers. These apparent regional extirpations provide further evidence that the species is disappearing from its range. Once extirpated from a region, natural recolonization of suitable habitats is unlikely to occur in the near future.

Sredl et al. (1997) reported that, during 1990 to 1997, Chiricahua leopard frogs were found at 61 sites in southeastern Arizona (southern populations) and 15 sites in central and east-central Arizona (northern populations). As a means to make the Arizona and New Mexico status information more comparable, the number of sites at which Chiricahua leopard frogs were observed from 1994 to 2001 in Arizona was tallied. Based on available data, particularly Sredl et al. 1997), Rosen et al. (1996b), and Service files, Chiricahua leopard frogs were observed at 87 sites in Arizona from 1994 to 2001, including 21 northern localities and 66 southern localities. Many of these sites have not been revisited in recent years; however, most populations are now extirpated from the Galiuro Mountains (Jones and Sredl 2004), frogs have not been seen for several years in the Chiricahua mountains, while others, such as in the Buckskin Hills area of the Coconino National Forest (Fossil Creek drainage), were recently (2000-2001) discovered. In 2000, the species was also documented for the first time in the Baboquivari Mountains, Pima County, Arizona (E. Wallace, pers. comm. 2000), extending the range of the species about 12 miles to the west. However, during a drought in 2002, populations in the Baboquivari Mountains and most populations in the Buckskin Hills were extirpated due to drying of stock tanks.

Intensive and extensive surveys were conducted by AGFD in Arizona from 1990 to 1997 (Sredl et al. 1997). Included were 656 surveys for ranid frogs within the range of the Chiricahua leopard frog in southeastern Arizona. Clarkson and Rorabaugh (1989), Wood (1991); Hale (1992); Rosen et al. (1995, 1996a and b, 2002), Jones and Sredl (2004), Suhre et al. (2004) and others have also extensively surveyed wetlands in southeastern Arizona. It is unlikely that many additional new populations will be found there. A greater potential exists for locating frogs at additional localities in Arizona's northern region, as witnessed by the new populations discovered in the Buckskin Hills. Sredl et al. (1997) conducted 871 surveys for ranid frogs in the range of the northern localities, but reported that only 25 of 46 historical Chiricahua leopard frog localities were surveyed during 1990 to 1997. The majority of these unsurveyed historical localities are in the mountains north of the Gila River in east-central Arizona. Additional extant populations of Chiricahua leopard frogs may occur in this area.

We currently know of 16 likely extant populations of the rim form of Chiricahua leopard frog in the Gila Basin, in Arizona, and 16 likely extant populations in New Mexico. We are aware of

about 17 likely extant populations of the southern form in the Gila Basin of Arizona, and no likely extant southern form populations occur in the Gila Basin of New Mexico.

Section 7 Consultation Environmental Baseline

All of the species considered in this opinion have been adversely affected by Federal actions that have undergone formal section 7 consultation (http://www.fws.gov/southwest/es/arizona). There have been 19 formal consultations and about 46 informal consultations conducted on CAP. A more thorough discussion of previous consultations on the CAP can be found in earlier CAP documents (BOs, BAs, etc.). A list of these consultations is found in Appendix 2. Although only two of the formal consultations have found the level of impact from that particular project to reach jeopardy (two for Gila topminnow, and one for spikedace, loach minnow, and razorback sucker [USFWS 1983, 1984b, 1994]), the incremental addition of adverse effects from these actions has contributed to the declining baselines of spikedace, loach minnow, Gila topminnow, and razorback sucker. The draft CAP Santa Cruz BO was a jeopardy (USFWS 1999b); that request for consultation was subsequently withdrawn and the proposed action was modified as described here. We have not done any previous consultations on CAP effects to Gila chub or Chiricahua leopard frog.

The ongoing implementation of the two conservation funds from the Gila Basin BO has already led to significant recovery actions for listed fish (Appendix 4). The management against nonindigenous species has been used to reduce problematic nonindigenous species in the Gila basin. The conservation of native fishes fund has funded recovery actions that have improved the conservation status of the five fish. It is likely that the Chiricahua leopard frog has also benefited from actions taken with these funds. A list of planned and completed actions for both funds can be found in Appendix 4.

EFFECTS OF THE ACTION

The analysis of the potential for CAP to introduce and spread nonindigenous aquatic species in the Gila River basin, and thereby affect the six species addressed in this biological opinion, is lengthy and complex. However, the various draft and final biological opinions, biological assessments, and background documents have addressed these effects at length. Therefore, the following discussion is a summary of those analyses, which are incorporated by reference. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

Introduction and spread of nonindigenous species is among the most serious and rapidly growing environmental problems today (Elton 1958, MacDonald et al. 1986, Coblentz 1990, Rosenfeld and Mann 1992, McKnight 1993, Simberloff et al. 1997, Claudi and Leach 2000). It is well documented as a major factor in the decline of southwestern native fishes and ranid frogs, including the six considered in this opinion (Miller 1961, Propst et al. 1986, Propst et al 1988, Carlson and Muth 1989, Miller et al. 1989, Aquatic Nuisance Species Task Force 1994, Sredl and Howland 1994, Cohen and Carlton 1995, Lassuy 1995, Rosen et al. 1995, Clarkson et al. 2005). Minckley (1991:145) succinctly summarized the situation for the aquatic fauna when he

wrote, "Native fishes of the American West will not remain on earth without active management, and I argue forcefully that control of nonindigenous warmwater species is the single most important requirement for achieving that goal." Arizona has one of the highest numbers of introduced fishes of any of the U.S. states (Figure 3).

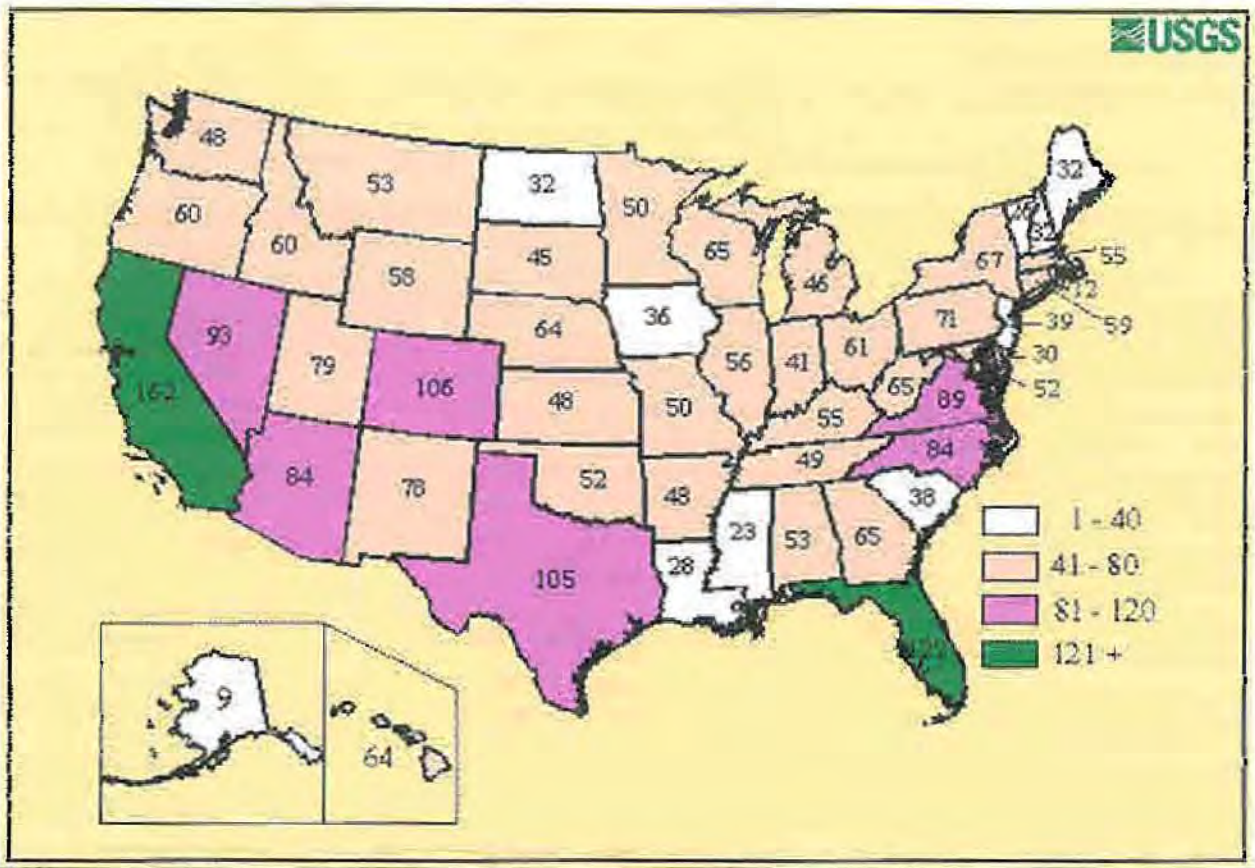

Figure 3. Number of nonindigenous fish species by state (http://cars.er.usgs.gov/posters/nonindigenous/nonind_fish_inland_waters.html).

CAP is an interbasin water transfer that will, like most interbasin water transfers, transport nonindigenous species across basin and subbasin boundaries (Davies et al. 1992, Meador 1992, 1996, Stefferud and Meador 1998, Claudi and Leach 2000)(see Table 8). CAP has already transported nonnative striped bass into the Gila basin (AGFD unpub. data), and juvenile striped bass were found during sampling at the Salt/Gila pumping plant, indicating they may be reproducing in the aqueduct (USBR unpub. data). CAP has already introduced Asian clam into the Santa Cruz subbasin at Tucson Water's Clearwater facility (K. Kingsley, SWCA, Inc., pers. comm., May 2001) and may be assisting in movement of pacu. White bass, which was only in Lake Pleasant in the Gila basin at the time CAP began pumping, has now found its way into the Santa Cruz subbasin, but only in the CAP aqueduct (Matter 1991, Clarkson 1998). In addition to direct transport of nonindigenous aquatic species, the CAP system provides a means of spread for species introduced through aquaculture, the aquarium trade, sport fish stocking, biological control, and bait-bucket transfer (Figure 4). Unauthorized stocking and "bait bucket" spread of species by the public is significantly increased by CAP through increased access by the public to nonindigenous species and to open waters, such as the aqueduct, recharge projects, created wetlands, and other features of CAP (Claudi and Leach 2001). In addition, because the trend in origin of nonindigenous fish has shifted from nonnative (North American) to exotic (foreign)(Figure 5), the number of different species "available" to be introduced to the Gila basin

Table 8. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Chicago Diversion	Great Lakes to Mississippi River	zebra mussel (*Dreissena polymorpha*)	USBR 1990
Chicago Sanitary and Ship Canal (Illinois and Michigan Canal)	Lake Michigan to Mississippi drainage	rainbow smelt (*Osmerus mordax*) ninespine stickleback (*Pungitius pungitius*) round goby (*Neogobius melanostomus*)	USBR 1990, Burr and Mayden 1980 Fuller et al. 1999 Claudi and Leach 2000
Chicago River Canal	Lake Huron to Lake Michigan	gizzard shad (*Dorosoma cepedianum*)	Miller 1957
Chicago Drainage Canal	Mississippi River to Great Lakes	"several species" of fish blue or skipjack herring (*Alosa chrysochloris*), gizzard shad	Hubbs and Lagler 1958 Claudi and Leach 2000
Erie Canal/New York Barge Canal	Great Lakes to Hudson and Mohawk Rivers Hudson River to Great Lakes Hudson River to Cayuga Lake Great Lakes to Finger Lakes	zebra mussel brindled madtom (*Noturus miurus*) alewife (*Alosa pseudoharengus*) white perch (*Morone americana*) gizzard shad quagga mussel (*Dreissena bugensis*)	USBR 1990 Scott and Crossman 1973, Scott and Christie 1963 (cited in Schmidt 1986) Miller 1957, Scott and Crossman 1973 Claudi and Leach 2000
Chemung Canal	Hudson River to Seneca Lake	comely shiner (*Notropis amoenus*)	Snelson 1968
Deleware-Hudson Canal	Hudson River to Delaware River	sand shiner	Smith 1985 (cited in Fuller et al. 1999)
Old Chenango Canal	Hudson River to Susquehanna River	emerald shiner (*Notropis atherinoides*) brassy minnow (*Hybognathus hankinsoni*)	Snelson 1968 Smith 1985 (cited in Fuller et al. 1999)

Table 8 cont'd. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Trent-Severn Waterway	Great Lakes to Kawartha and Muskoka Lakes	zebra mussel common carp (*Cyprinus carpio*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), northern pike (*Esox lucius*), Eurasian watermilfoil (*Myriophyllum spicatum*), spiny waterflea (*Bythotrephes cederstroemi*)	USBR 1990 Claudi and Leach 2000
Rideau Canal	Great Lakes to Rideau Lakes Great Lakes to Ottowa River	zebra mussel yellow bullhead (*Ameiurus natalis*) European frog-bit (*Hydrocharis morsus-ranae*)	USBR 1990 McAllister and Coad 1974 Claudi and Leach 2000
Champlain Canal/ Hudson Barge Canal misc. hydroelectric connectives	Hudson River to Lakes Champlain and Richeleau Great Lakes to Hudson Bay streams to Lake Superior	pickerel (*Esox americanus*), logperch (*Percina caprodes*), blueback herring (*Alosa aestivalis*), gizzard shad, sand shiner (*Notropis stramineus*) fallfish (*Semotilus corporalis*)	Scott and Crossman 1973, Plosila and LaBar 1981, Schmidt 1986, Fuller et al. 1999 Hubbs and Lagler 1958
Fox-Wisconsin Canal	Mississippi River to Great Lakes	shortnose gar (*Lepisosteus platostomus*) bowfin (*Amia calva*) river darter (*Percina shumardi*) sauger (*Stizostedion canadense*)	USBR 1990 Becker 1983 Fuller et al. 1999
Welland Canal	Lake Ontario to upper Great Lakes Lake Erie to Lake Ontario	alewife sea lamprey (*Petromyzon marinus*) American eel (*Anguilla rostrata*), white perch gizzard shad	Miller 1957, Hubbs and Lagler 1958, Hubbs and Lagler 1958, USBR 1990, Scott and Crossman 1973, Mills et al. 1997 (as cited in Fuller et al. 1999) Miller 1957
Coachella Canal	Colorado River to Coachella Valley (southern CA)	striped bass (*Morone saxatilis*)	Swift et al. 1993

Table 8 cont'd. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
All-American Canal	Colorado River to Imperial Valley (southern CA)	Rio Grande leopard frog (*Rana berlandieri*)	J. Rorabaugh, USFWS, pers. comm., 1998
Los Angeles Aqueduct	Owens River to Santa Clara River (southern CA)	Owens sucker (*Catostomus fumeiventris*)	Moyle 1976
California Aqueduct	Central and northern inland California drainages to southern California coastal drainages	Sacramento squawfish (*Ptychocheilus grandis*), striped bass, interior prickly sculpin (*Cottus asper*), inland silverside (*Menidia beryllina*), white catfish (*Ameirus catus*), tule perch (*Hysterocarpus traski*), bigscale logperch (*Percina macrolepida*), chameleon goby (*Tridentiger trigonocephalus*), blackfish (*Orthodon microlepidus*), Asian clam (*Corbicula fluminea*)	Swift et al. 1993 Claudi and Leach 2000
	San Francisco Bay to San Luis Reservoir and O'Neill forebay (S. CA)	starry flounder (*Platichthys stellatus*)	Moyle 1976
Colorado River Aqueduct	Colorado River to San Diego coastal drainages	goldfish (*Carassius auratus*) common carp (*Cyprinus carpio*)	Swift et al. 1993
Central Arizona Project	Colorado River to Gila River (AZ)	striped bass	Arizona Game and Fish Department unpublished data
Morenci Diversion	Black River to Eagle Creek (AZ)	smallmouth bass (*Micropterus dolomieu*)	Marsh et al. 1990
Tenn-Tom Waterway	Tombigbee River (Mobile Bay) to Tennessee River (Mississippi drainage) (TN/AL)	blacktail shiner (*Cyprinella venusta stigmatura*) weed shiner (*Notropis texanus*) Atlantic needlefish (*Strongylura marina*)	Etnier and Starnes 1993
	Tennessee River to Tombigbee River	yellow bass (*Morone mississippiensis*)	Boschung 1992 (as cited in Mettee et al. 1996)
		yellow perch (*Perca flavescens*)	Mettee et al. 1996

Table 8 cont'd. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Project	References
unnamed diversion	Tallaposa River to Conecuh River (AL)	blacktip shiner (*Notropis atrapiculus*)	Lee et al. 1980
SE Florida Water Management District's Canal L31W	southeastern Florida to Everglades National Park	oscar (*Astronotus ocellatus*)	Courtenay 1989
Tamiami Canal	southeastern Florida to Everglades area	walking catfish (*Clarius batrachus*)	Claudi and Leach 2000
Ely Ouse to Essex Transfer	Great Ouse to River Stour, (Great Britain)	diatom (*Stephanodiscus* sp.) zander (*Stizostedion lucioperca*)	Guiver 1976 (as cited in Meador 1992)
Severn-Thames Transfer	Thames River to River Severn (Llandegfedd Reservoir) (Great Britain)	roach (*Rutilis rutilus*) dace (*Leuciscus leuciscus*)	Mann 1988, Solomon 1975
Tajo-Segura Transfer	Tajo to Segura River (Spain)	gudgeon (*Gobio gobio*)	Garcia de Jalon 1987
numerous canals in Russia and Europe	Aral, Black and Caspian drainages to Atlantic Ocean and North and Baltic drainages	zebra mussel	Garton et al. 1993
Orange River Project (Orange-Fish Tunnel)	Orange River to Great Fish River and Sundays River (South Africa)	sharptooth catfish (*Clarias gariepinus*) smallmouth yellowfish (*Barbus aeneus*) rock barbel (*Geophyroglans sclateri*) Orange R. mudfish (*Labeo capensis*)	MacDonald et al. 1986, Laurenson and Hocutt 1986, Petitjean and Davies 1988

Table 8 cont'd. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Panama Canal	Atlantic Ocean to Pacific Ocean	Atlantic pipefish (*Oostethus brachyurus lineatus*)	Chickering 1930
	Pacific Ocean to Atlantic Ocean	goby (*Lophogobius cristulatus*)	Rubinoff and Rubinoff 1968
	Caribbean Ocean to Gatun Lake	snook (*Centropomus* sp.) tarpon (*Megalops atlanticus*)	Rubinoff 1970
Suez Canal	Red Sea to Mediterranean Sea	algae - 2 species, plants - 12 species, invertebrates - 72 species, fish - 27 species	Por 1978
	Mediterranean Sea to Red Sea	algae - 1 species, invertebrates - 44 species, fish - 15 species	

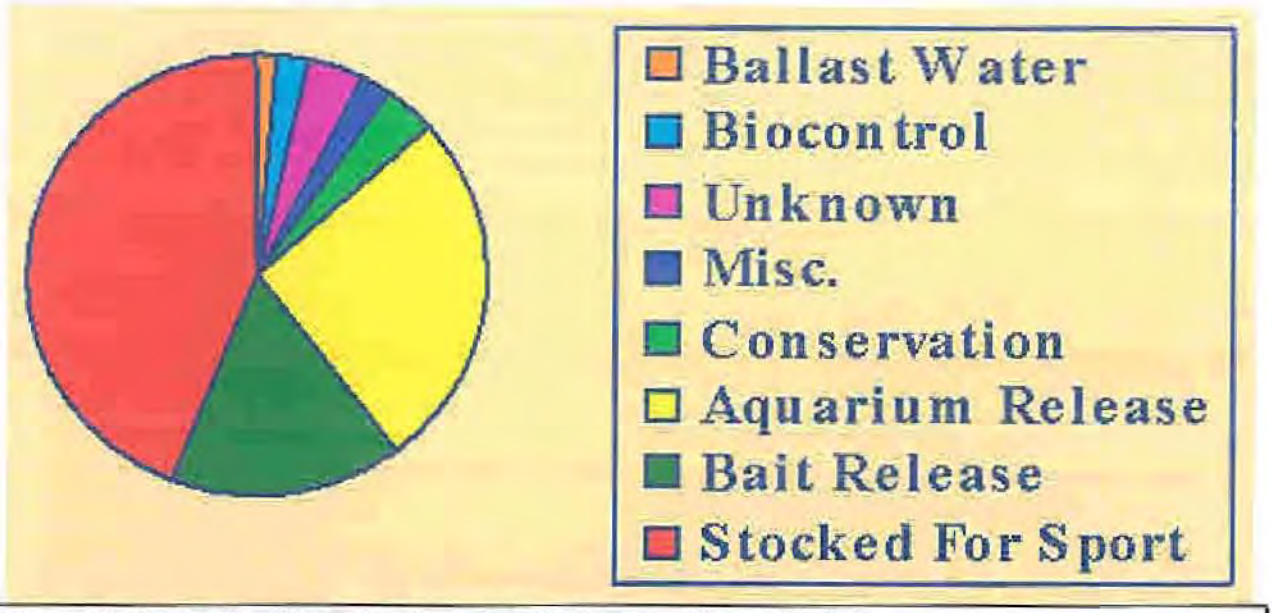

Figure 4. Methods of introduction of nonindigenous fish to the U.S. (http://cars.er.usgs.gov/posters/nonindigenous/nonind_fish_inland_waters.html).

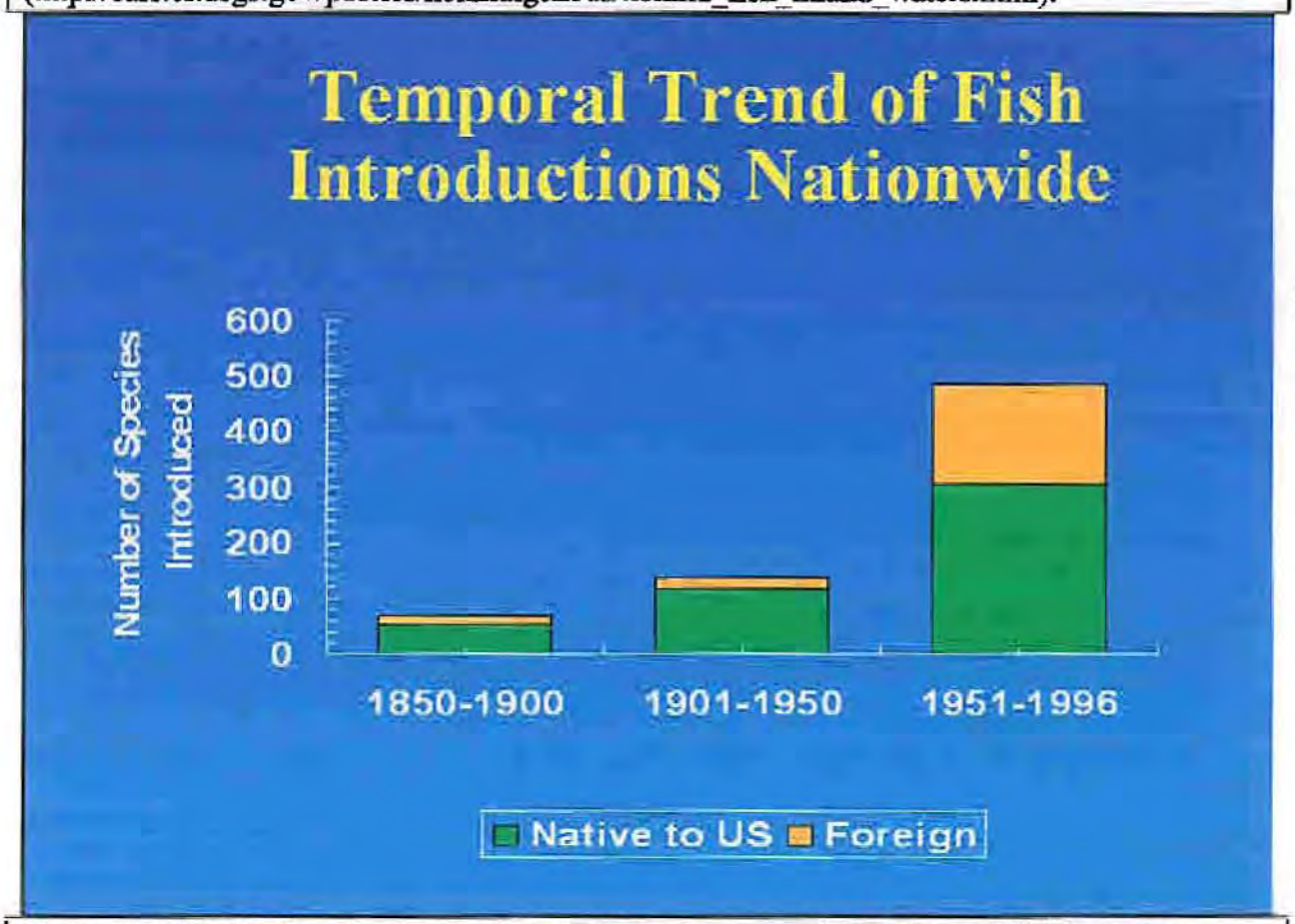

Figure 5. U.S. fish introduction trends (http:\\nas.es.usgs.gov). **"Native to US" includes species which are native to some portion of the United States, and which have been introduced into other areas of the United States that are outside of their historical range**

is continually growing. The data in Figure 3 also demonstrate the rapidly increasing number of fish introductions being made in the United States.

In Arizona, release or dispersal of new nonindigenous aquatic organisms is a continuing phenomenon. Despite the information available over the past decade regarding the serious consequences, there continue to be deliberate efforts to introduce new species. In 1987-91 the State of Utah proposed to introduce rainbow smelt, a native of the northeastern U.S., into Lake Powell on the Colorado River, but dropped the proposal due to substantial opposition (Utah Dept. of Natural Resources 1990). In 1997, CAWCD proposed to introduce black carp, a native of Asia, into the CAP aqueduct for the control of possible future invasions of zebra mussel (J. Garza, CAWCD, pers. comm., October 1997). In addition, since the mid 1990's, aquacultural use of pacu, a native of South America, has been licensed by the State of Arizona (Univ. of Arizona 1998). Pacu has now escaped into the wild, and a trophy size angling record has been established for a pacu caught in Lake Pleasant, where CAP water is stored (AGFD 2001). A pacu was also caught in the CAP aqueduct near the Salt River in 2006 (R. Clarkson, Reclamation, October 2006).

In addition, unauthorized and presumably unintentional introductions continue to occur, such as the 1999 appearance in the Colorado River of giant salvinia, an aquatic plant native to South America, which has been widely traded in plant nurseries in the Phoenix area (Dahlberg 2000). Unauthorized introductions are also illustrated by several recent records in urban lakes in the basin of piranha, a prohibited but popular group of aquarium species from South America, and shortnose gar, a native of the Mississippi drainage and a prohibited species presumably released from an aquarium, (AGFD unpub. data, AGFC 1995). There has also been an unauthorized introduction of northern pike into Parker Canyon Lake (Graham 2000), gizzard shad into Roosevelt Lake (Kirk Young, AGFD, pers. comm., March 2007), and inland silverside into Lake Pleasant (Tony Robinson, AGFD, pers. comm. January 2006). Augmentation stocking of some nonindigenous sport fish continues, such as the continuing AGFD stocking of rainbow trout in the Verde River and Service stocking of channel catfish into various waters of the San Carlos Indian Reservation (USFWS 1995b and 1999a). Accidental introductions also continue, such as the 1999 introduction of gizzard shad into the Colorado River basin as an accidental inclusion in a Service stocking of largemouth bass for sport fishing (J. Brooks, USFWS, pers. comm., June 2000). Previously introduced nonindigenous species continue to increase their ranges within the Gila River basin, such as the gradual upstream expansion in the upper Verde River of flathead catfish, a Mississippi drainage native (Rinne 1999). Tilapia, an African fish widely used for aquaculture in Arizona, continues to move upstream in the Salt River and has surmounted one minor (Granite Reef) and one major (Stewart Mountain) dam, presumably by human assistance.

A panel convened by the Ecological Society of America to consider invasions of nonindigenous species concluded that, although such invasions are a major global problem, it is difficult to identify what species will become invaders and what locations and habitats will be most likely to be invaded (Mack et al. 2000). A great deal of effort has been expended attempting to predict which nonindigenous aquatic species would be successful at colonizing areas opened to invasion due to interbasin water transfers (Grabowski et al. 1984, Balon et al. 1986, USBR 1990, Matter 1991). While these analyses are valuable at identifying concerns, they are limited in their usefulness, because as Laurenson and Hocutt (1985) concluded "prediction of the success of an

exotic is difficult." The literature on nonindigenous species invasions is replete with examples of species that succeeded where the best analysis confidently predicted they would not. For example, pink salmon was stocked into the Great Lakes with an expectation that it could not successfully reproduce because it was considered an "obligatory anadromous fish" that could only grow to maturity in the ocean. However, pink salmon became quite successful in the Great Lakes and are the only known population of this species reproducing in fresh waters (Kwain and Lawrie 1981). Grass carp were stocked into many areas in North America after analyses predicted they were unlikely to reproduce. However, there is now documented reproduction in several parts of the Mississippi basin and independent Gulf of Mexico drainages (Brown and Coon 1991, Howells 1994, Raibley et al. 1995), and migrating grass carp have been documented in the Columbia River (Loch and Bonar 1999). Striped bass were not expected to reproduce in Lake Mead, but did so prolifically (Minckley 1991).

There are many species of aquatic organisms known to be presently expanding their ranges within North America but which have not yet reached Arizona. In addition to these, there are species expanding their ranges worldwide and species that we have not yet heard of, but which may soon become the newest species considered desirable by the aquaculture industry or the species with consumer demand in the aquarium trade. Some of these species may never reach a place where they could be introduced or spread via CAP. Others may reach that stage, but may not succeed in colonizing the Gila River basin. However, at least some species over the 100-year project life will successfully colonize the Gila River basin via CAP and invade the habitats of the six listed species considered in this consultation to the detriment of those species. Examples of species whose ranges are known to be expanding in North America and which are considered to be potential threats to native fishes, include the round goby, rainbow smelt, American shad, sheepshead minnow, bighead carp, silver carp, black carp, rudd, Oriental weatherfish, walking catfish, suckermouth catfish, armored catfish, bitterling, roach, gizzard shad, bigscale logperch, piranha, swamp eel, pike topminnow, shortfin molly, ide, snakehead, tench, ruffe, convict cichlid, white perch, Atlantic salmon, giant marine toad, giant rams-horn snail, zebra mussel, opossum shrimp, New Zealand mudsnail, spiny water flea, mitten crab, rusty crayfish, fountain grass, stonewort, water hyacinth, European frog-bit, hydrilla, and many more (Deacon et al. 1964, Moyle 1976, Burr and Mayden 1980, Freeze and Henderson 1982, Welcomme 1988, Bowler 1989, Platania 1990, Westman 1990, Howells et al. 1991, Horne et al. 1992, AGFC 1995, Lever 1996, Dill and Cordone 1997, Echelle and Echelle 1997, Fuller et al. 1999, Claudi and Leach 2000, Nico and Martin 2000, Volpe et al. 2000, USGS 2001).

Water deliveries through the CAP aqueduct began in 1985. At that time, only one nonnative species of fish (striped bass) was known from the Colorado River near the CAP intake, that was not also already found somewhere in the Gila River basin (Grabowski 1984). By 1989, striped bass were common in the CAP aqueduct (Mueller 1989). In 1992, CAP water was first placed into Lake Pleasant. In 1993, striped bass was first found in Lake Pleasant (AGFD 1993). This was the first introduction of a new species into the Gila River basin via the CAP.

When the 1994 biological opinion was written, we were only vaguely aware of a species called pacu. However, it was already common in the aquarium trade and already, or soon thereafter, being licensed for aquaculture use along the lower Gila River (Kevin Fitzsimmons, Univ. of AZ, pers. comm., April 2001; Univ. of Arizona 1998). By 1996, pacu was taken repeatedly in Lake

Havasu, including near the CAP intake (C. Minckley, USFWS, pers. comm., 2001). By late 1999, pacu had appeared in Lake Pleasant (AGFD 2001).

Aquatic habitats created by CAP water, or water made available by other use of CAP water, provide enhanced habitat and opportunities for stocking nonindigenous aquatic species. Nonindigenous grass carp, redear sunfish, and mosquitofish have already been introduced directly into the CAP and interconnected features (such as recharge areas) for biological control, and introduction of black carp has been proposed (Bawden 1994; USFWS unpub. data; J. Garza, CAWCD, pers. comm., Oct. 1997). Due to objections by the Service and Reclamation, black carp were not stocked (CAWCD 2001). Aquaculture in some aqueduct distribution canals has been considered, but is not planned.

Nonindigenous species are likely to leave CAP and enter the Gila River basin waters through connections with other canal systems, irrigation releases, groundwater recharge, bait-bucket transfer, water storage in Lake Pleasant, recreational lakes, and accidental releases due to technical failures or emergencies. Indeed, this has already occurred. Ponded waters from CAP or CAP in-lieu water will form habitat highly suited for nonindigenous species and are likely to be stocked with nonindigenous species, intentionally or unintentionally, serving as sources for nonindigenous dispersal into surrounding waters. "Artificial waters seem to serve as stepping stones for exotic species as they spread geographically" (Blinn and Cole 1991:110).

CAP has a project life of 100 years. Over that lengthy period, we are reasonably certain that more than the few species that have already moved via CAP will be introduced or assisted in their spread by CAP. CAP is an aquatic "highway" reconnecting human-isolated fragments of the Gila basin surface water and substantially enhancing the ability of nonindigenous aquatic species to move throughout the system. This connection will not benefit native fish, but it is likely to benefit nonindigenous aquatic species by providing enhanced opportunities for movement between the Colorado River and Gila basin and between subbasins of the Gila River.

Over the 100-year project life, substantial changes are expected in the project, including water use, technology, human population, available nonindigenous species, climatic trends, and other factors. Therefore, our analysis uses a broad-scale approach, focusing on existing data on movement of species already occurring through the CAP aqueduct and connected canal systems (Grabowski et al. 1984, Mueller 1989, 1997, Clarkson 1998, 1999, and 2001, Bettaso 2000)(Table 9) and through other interbasin water transfers (Table 8). In addition, we assessed information on existing specifics of CAP and the Gila River basin aquatic ecosystem to determine that nothing about CAP indicates it is sufficiently different from other interbasin water transfers to support a presumption that it would not fit into the general pattern illustrated in Table 8. Although significant impediments to species movement through the CAP system exist (CAWCD 1995), they do not prevent such movement (e.g. striped bass, white bass, Asian clam) nor are they any greater than those overcome by species moving through interbasin water transfers elsewhere (Rubinoff and Rubinoff 1968, Guiver 1976, Laurenson and Hocutt 1985, Swift et al. 1993).

Nonindigenous species are extremely difficult, if not impossible; to remove once established (Aquatic Nuisance Species Task Force 1994, Kapuscinski and Patronski 2005, Desert Fishes

Table 9. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal (bold face common name indicates the species has been found in the Tucson reach of CAP). ND = no date for report.

SPECIES	CAP aqueduct[7]	CAP aqueduct[8]	SRP and F-CG Canals[9]
threadfin shad (*Dorosoma petenense*)	X	X	X
rainbow trout (*Oncorhynchus mykiss*)			X
brook trout (*Salvelinus fontinalis*)			X
common carp (*Cyprinus carpio*)	X	X	X
grass carp (*Ctenopharyngodon idella*)		X	X
grass carp X bighead carp hybrid (*C. idella* X *Aristichthys nobilis*)			X
goldfish (*Carassius auratus*)	X	X	X
red shiner (*Cyprinella lutrensis*)	X	X	X
beautiful shiner (*Cyprinella formosa*)			X
fathead minnow (*Pimephales promelas*)			X
Rio Grande leopard frog (*Rana berlandieri*)			X
bullfrog (*Rana catesbeiana*)			X
spiny softshell (*Trionyx spinifera*)		X	X
red-eared slider (*Trachemys scripta*)			X
longfin dace[1] (*Agosia chrysogaster*)			X
roundtail chub[1] (*Gila robusta*)			X
bigmouth buffalo (*Ictiobus cyprinellus*)			X
desert sucker[1] (*Catostomus* [*Pantosteus*] *clarki*)	X		X
Sonora sucker[1] (*Catostomus insignis*)	X		X
razorback sucker[1] (*Xyrauchen texanus*)	X	X[3]	
flathead catfish (*Pylodictus olivaris*)	X	X[4]	X
channel catfish (*Ictalurus punctatus*)	X	X	X
yellow bullhead (*Ameiurus natalis*)	X	X	X
black bullhead (*Ameiurus melas*)		X	X
mosquitofish (*Gambusia affinis*)	X		X
sailfin molly (*Poecilia latipinna*)			X
shortfin molly (*Poecilia mexicana*)			X
guppy (*Poecilia reticulata*)			X

Table 9 cont'd. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal (bold face common name indicates the species has been found in the Tucson reach of CAP). ND = no date for report.

SPECIES	CAP aqueduct[7]	CAP aqueduct[8]	SRP and F-CG Canals[9]
swordtail (*Xiphophorus variatus*)			X
striped bass (*Morone saxatilis*)	X	X	X
white bass (*Morone chrysops*)		X	
yellow bass (*Morone mississippiensis*)			X
largemouth bass (*Micropterus salmoides*)	X	X	X
smallmouth bass (*Micropterus dolomieu*)		X[5]	X
redear sunfish (*Lepomis microlophus*)	X	X	X
bluegill (*Lepomis macrochirus*)	X	X	X
green sunfish (*Lepomis cyanellus*)	X	X	X
black crappie (*Pomoxis nigromaculatus*)	X		X
walleye (*Stizostedion vitreum*)			X
Rio Grande cichlid (*Cichlasoma cyanogutattum*)			X
firemouth cichlid (*Cichlasoma meeki*)			X
convict cichlid (*Cichlasoma nigrofasciatum*)			X
oscar (*Astronotus ocellatus*)			X
blue tilapia (*Tilapia aurea*)			X
Mozambique tilapia (*Tilapia mossambica*)			X
redbelly tilapia (*Tilapia zilli*)			X
black buffalo (*Ictiobus niger*)			X
pacu (*Colossoma macropomum?*)		X[6]	
yellow perch (*Perca flavescens*)			X
snail[2] (*Helisoma* [=*Planorbella*] *campanulata*)	X	ND	ND
Asian clam[2] (*Corbicula fluminea*)	X	ND	X
red swamp crayfish (*Procambarus clarki*)		ND	X
freshwater sponge (*Porifera*)	X	ND	
chara[1] (*Chara* sp.)	X	ND	
spiny naiad[1] (*Najas* sp.)	X	ND	

Table 9 cont'd. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal (bold face common name indicates the species has been found in the Tucson reach of CAP). ND = no date for report.

SPECIES	CAP aqueduct[7]	CAP aqueduct[8]	SRP and F-CG Canals[9]
curlyleaf pondweed (*Potamogeton crispus*)	X	ND	X
sago pondweed[1] (*Potamogeton pectinatous*)	X	ND	X
Horned pondweed[1] (*Zannichellia palustris*)		ND	X
water-milfoil (*Myriophyllum brasiliense*)		ND	X
Eurasian water-milfoil (*Myriophyllum spicatum*)		ND	X
algae[1] (*Nostoc* sp.)		ND	X
algae[1] (*Cladophora* sp.)	X	ND	X

[1] native
[2] Mueller (1990) mentions snails and insects being present, but does not document species of invertebrates other than the three in this table. *Helisoma campanulata* is a nonindigenous species, but there are native *Helisoma* and the identification may be erroneous.
[3] Pers. comm. from J. Warnecke, AGFD to R. Clarkson, BR, 1/23/2003
[4] Pers. comm. from R. Clarkson, BR, to P. Barrett, USFWS, 11/23/2004
[5] Pers. comm. from R. Clarkson, BR, to P. Barrett, USFWS, 10/8/2004
[6] Pers. comm. from R. Clarkson, BR, to D. Duncan, USFWS, 10/30/2006
[7] Mueller (1989)
[8] Clarkson (1998, 1999, 2001) Marsh (2004), Marsh and Kesner (2006, 2007)
[9] Marsh and Minckley (1982), Matter (1991), Wright and Sorensen (1995), Clarkson (1998, 2001), Girmendonk and Young (1997), Marsh (1999, 2004), Bettaso (2000), Marsh and Kesner (2006), J. Rorabaugh, USFWS, pers. comm., June 2007

Team 2006). If possible, control or removal can be costly, such as the predicted annual costs of $90 million for ruffe control (Great Lakes Fishery Commission 1992, as cited in Courtenay 1995). It may also entail use of toxic substances that may be controversial with the public and may affect many species besides the target nonindigenous species (DeMarais et al. 1993, Inchausty and Heckmann 1997, Finlayson et al. 2000). Therefore, survival and recovery of the spikedace, loach minnow, Gila topminnow, razorback sucker, Gila chub, and Chiricahua leopard frog, require proactive prevention of the invasion or spread of nonindigenous species to the maximum extent possible.

Operations and Maintenance

Canal associated operations and maintenance by CAWCD have the potential to adversely affect the listed fish species. It is not likely that the Chiricahua leopard frog will occur within the canal system. Though the monitoring to date has found few native fishes in the canal system, the long operational life of the CAP makes it reasonably certain that the five listed fish species will occur during operations and maintenance activities, and be directly affected.