

**STATUS OF UNLISTED NATIVE FISHES OF THE GILA RIVER BASIN,  
WITH RECOMMENDATIONS FOR MANAGEMENT**

**DESERT FISHES TEAM  
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## EXECUTIVE SUMMARY

**Purpose:** This report reviews the status of seven native warm water fishes in the Gila River basin of central Arizona, southwestern New Mexico, and northern Sonora that are not listed under the federal Endangered Species Act. These species are *Agosia chrysogaster* longfin dace, *Catostomus insignis* Sonora sucker, *C. latipinnis* flannelmouth sucker, *Elops affinis* machete, *Mugil cephalus* striped mullet, *Pantosteus clarki* desert sucker, and *Rhinichthys osculus* speckled dace. It includes post-1967 conservation actions taken by all agencies, organizations, or parties. The report provides recommendations for future conservation actions for each species.

**Organization:** A summary for each species is given in the text. Table 1 describes historical and modern range of each species. Table 2 describes repatriation efforts and their success. Restoration and conservation actions are provided in Table 3. Table 4 contains recommendations for further transplants and repatriations, and conservation actions. A literature cited section completes the report—it provides examples of supporting documentation, but is not comprehensive.

**Conclusions:** One species is extirpated from the basin, four others are widespread throughout their historical range, although showing moderate decline. Two other species are occasional visitors from the Gulf of California but restricted from reaching historical range during most years. The distribution and abundance of all species present in the basin have

declined in modern times. This trend continues and is accelerating. Few conservation actions have occurred during the 37-year period assessed. Although repatriation has been the primary management effort, it has occurred for only a few of the species, and with limited success. Most conservation actions have been directed at listed species, with benefits accruing to non-listed species on an incidental basis.

**Recommendations:** Development of conservation plans that include direction for removal of nonnative species, protection and monitoring of existing populations, habitat reclamation and restoration, and repatriation into suitable habitats would set the groundwork for management of these species. On-the-ground implementation of plan actions is paramount to conservation of the species. Existing conservation strategies and techniques would, if implemented, contribute substantially to stemming the decline of these fishes. There are proven techniques and processes available for conservation for native fishes, and management of these species does not depend on additional research on their biology and ecology. We believe control and removal of nonnative fishes and other nonnative aquatic flora and fauna is the most urgent and overriding need in preventing continuing decline and ultimate extinction of the native fish assemblage of the Gila River basin. Notwithstanding, innovative strategies and techniques incorporating new knowledge and data are also important and should be investigated.

# STATUS OF UNLISTED NATIVE FISHES OF THE GILA RIVER BASIN, WITH RECOMMENDATIONS FOR MANAGEMENT

## Introduction

Like the entire indigenous fish fauna of the American southwest, native warm water fishes of the Gila River basin in Arizona and New Mexico, USA, and Sonora, Mexico, are critically imperiled. In this report, we assess the status of seven warm water species of the basin (*Agosia chrysogaster* longfin dace, *Catostomus insignis* Sonora sucker, *C. latipinnis* flannelmouth sucker, *Elops affinis* machete, *Mugil cephalus* striped mullet, *Pantosteus clarki* desert sucker, *Rhinichthys osculus* speckled dace)<sup>1</sup> that are not listed under the federal Endangered Species Act. We have prepared this report to complement our earlier report on listed warm water species (Desert Fishes Team 2003), and to bring attention to a fauna that has been overlooked, and which is slowly but clearly diminishing.

Flannelmouth sucker, a freshwater species, has already been lost from the Gila River basin, and is declining elsewhere in its range. Longfin dace, Sonora sucker, desert sucker, and speckled dace are freshwater fishes, and all show moderate declines in distribution in modern times from historical, but remain widespread throughout their historical ranges. Striped mullet and machete are salt-water species and infrequent visitors to the lowermost Gila River only when flows connect the lower Colorado River with the Gulf of California. Passage of the Endangered Species Act in 1973 subsequently resulted in 67% of the Gila

River basin's fish species being listed as threatened or endangered. Since then, most management efforts have been directed at recovery for those listed species, with benefits to unlisted species occurring only incidentally. Conservation efforts for unlisted species have been limited in number and scope, and have primarily accrued from efforts to promote listed species.

There have been no conservation efforts for flannelmouth sucker in the Gila River basin. Immediate efforts should be made to restore it through stocking into suitable habitats. Conservation efforts for longfin dace, Sonora sucker, desert sucker, and speckled dace have been limited in number and scope, and of slight long-term effectiveness in stemming their declines. Increased management efforts on their behalf should be instituted. Machete and striped mullet would benefit from restoration of flows in the lower Colorado River.

All species suffer from anthropogenic disruption and fragmentation of watersheds. These actions intensify the accumulative impact of isolated populations becoming extirpated with little potential for re-colonization from adjacent sources (Fagan 2002). Thus, efforts to restore locally extirpated populations are essential to prevent a downward spiral of loss over a metapopulation or watershed level. A community approach when dealing with transplants or range extensions for all fish, including federally listed or proposed species should be followed (Jackson et al. 1987). This would allow nonlisted species to be considered for repatriation and protection along with threatened and endangered species where and when appropriate.

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<sup>1</sup>The Gila River basin has 21 native fish species, which represents an addition of one species (*Elops affinis*) to the fauna previously reported (Desert Fishes Team 2003, Clarkson 2004). In addition to the seven species considered here, twelve were considered in an earlier report, plus there are two native trouts that are not addressed (Desert Fishes Team 2003).

The information used in this report was gathered from many sources, primarily the SONFISHES database (Fagan et al. 2002). Other sources included published literature, agency and non-government organization reports, and the collective field experience, knowledge, and expertise of participants in the Desert Fishes Team.

There are multiple approaches to analyzing collection databases (Fagan et al. 2002). Our approach was to group records of species at a stream level within a county, even though there may have been multiple localities where fish had been recorded in that water within the county. For example, there have been hundreds of collections of fish at multiple sites in Aravaipa Creek, but our analysis only considered presence/absence in the two counties through which it flows. We defined historical records being those between ca. 1840 and 1979, and modern records being those between 1980 and 2003. Localities with modern records of a species, but no historical records, were considered occupied historically. We included the few occurrence records stemming from artificial translocations and reintroductions, but not those replaced with stock that had been removed from the same source during renovation efforts (e.g., Sonora sucker in O'Donnell Canyon).

Our approach tended to understate the actual rarity of species, particularly in modern times (i.e., many sites where the species was historically abundant were designated as occupied in modern times based solely on a few individuals collected during that 23-year period). Conversely, the "absence" of a species from a particular water may not have meant the species was actually absent. It may merely have reflected an absence of records—either the stream was not sampled, specimens were not accessioned to a museum, or field collection notes were not retained.

We determined decline as percentage of sites remaining occupied in modern times. Our estimates of decline are conservative.

Contemporary data and personal knowledge, although not comprehensive, suggest a greater decline in range and numbers of sites occupied than reported here. Native species are now dramatically reduced from many localities where they were abundant in the 1980's and 1990's. For example, all native species are now exceedingly rare in the Salt River above Roosevelt Reservoir, as are several species in the Verde River. However, collection history is replete with examples of species remaining undetected in a water for years and decades, only to recur during sampling. Unfortunately, many waters where native species previously waxed and waned are now burdened with a vast predator load that may drive populations of the native species below the point of no return (Jahrke and Clark 1999, Rinne 2000, Marsh et al. 2003). Additionally, efforts to restore listed species have occasionally resulted in loss of nonlisted species (Rinne 1975, Propst et al. 1992).

Reasons for decline of these species are well documented in published literature, agency reports, and common knowledge. Introduction and spread of nonnative aquatic species continues to be a major factor in displacement of native species. Habitat destruction from a variety of human activities has been an equal and interactive factor. We believe the control and removal of nonnative fish and certain other aquatic flora and fauna is the most urgent and overriding need in preventing the continued decline and ultimate extinction of the native fish assemblage of the Gila River basin.

Following is a brief summary narrative for each species, which is based upon information detailed in the accompanying tables. Historical (1840-1979) and modern distribution (1980-2003) of these seven species is in Table 1. Accomplishments to-date in establishing transplanted or replication populations are in Table 2. Conservation activities are in Table 3, which also includes monitoring and research activities. Table 4 includes recommendations for replications and additional activities. The

list of replication sites is not inclusive and other suitable sites likely exist. A literature cited section completes the report—it provides examples of supporting documentation, but is not comprehensive.

### Species accounts

#### ***Agosia chrysogaster* Longfin dace.**

Historical range of longfin dace was from upland- to low-desert streams throughout the Gila River and other drainages in Arizona, New Mexico, and Sonora. Additionally, it was successfully transplanted to waters outside its historical range, including the Rio Grande, Zuni, and Mimbres rivers in New Mexico, and Virgin River in Nevada. Longfin dace currently remains widespread throughout its range. It is probably the most successful, highly adaptable, cyprinid fish native to the southwest. Longfin dace can survive for short periods during extreme drought in low water conditions by taking refuge under filamentous algal mats and moist debris. Dispersal into new habitats occurs rapidly after precipitation events reconnect dry streambeds and reopen previously occupied habitat. Information on its biology and ecology may be found in many sources, including but not limited to (Minckley 1969, 1973b, 1981, 1999, Minckley and Barber 1971, Fisher 1979, Kepner 1982, Meffe and Minckley 1987, Grimm 1988, Sublette et al. 1990, Rinne 1992, Stefferud and Stefferud 2003, Eby et al. 2003, Anon 2004a).

Although longfin dace is resilient, some populations in the Gila River basin have been eliminated. Of the 257 locations where it was recorded during 1840 through 2003, 214 (83%) retain longfin dace (Table 1). Reasons for disappearance from localities are multiple, but revolve around dewatering or other alteration of habitats, and introduction of nonnative species. The probability of local extirpation<sup>2</sup> of the species is low (Fagan et al.

2002) because it still is present throughout most of its range.

Longfin dace was successfully transplanted to three different wild locations within the Gila River basin, but lost from a fourth transplant site that went dry (Table 2). Other than these efforts, the species has not been subject to direct conservation and management activities. Instead, federal and state actions that were focused on federally listed or proposed fishes have indirectly benefited longfin dace (Table 3). Restoration of longfin dace into previously occupied or suitable waters within its historical range would contribute significantly to its survival and health (Table 4). Due to its decline basin wide, continuing anthropogenic disturbances, and impacts from nonnative species, we recommend that longfin dace be listed under the Endangered Species Act as threatened (Table 4). This is consistent with previous recommendations from the Desert Fishes Recovery Team and federal agencies (Minckley 1993, U.S. Fish and Wildlife Service 1994a).

#### ***Catostomus insignis* Sonora sucker.**

Sonora sucker was widespread and abundant in the Gila and Bill Williams drainages, although it was not collected in the Gila River downstream of the Salt River. It occurs in small to moderate size streams and small rivers up to about 6,500' elevation, and even water delivery canals in the Phoenix metropolitan area. It is an obligate riverine species, and does not persist in impoundments. Its biology and ecology have been described (Minckley and Alger 1968, Minckley 1973b, 1981, Clarkson and Minckley 1988, Sublette et al. 1990, Rinne 1992, James 1993, U.S. Fish and Wildlife Service 1994, Robinson et al. 1998, Propst 2002, Eby et al. 2003, Bonar et al. 2004, Anon 2004a).

<sup>2</sup> The term "local extirpation" (Fagan et al. 2002) was defined by W.F. Fagan (pers. comm., email of 6/21/2004 to P.C. Marsh) as follows: "A "local" site means any specific 5 km length of stream reach. So "local extinction" means loss of species X from that 5 km reach of stream.

And "local extinction risk" is the probability, taken across all such 5 km occurrences for species X, that species X has gone locally extinct. We focused on quantifying variation in local extinction risk among species and then trying to understand how spatial distribution affects that variation."

Modern occurrences of Sonora sucker show it remains in 93 (73%) of the 127 locations in which it was recorded (Table 1). It has a low probability of local extirpation (Fagan et al. 2002), however, fragmentation of range and isolation of populations could further reduce its occurrence in a watershed. Reasons for decline include dewatering and alteration of habitats, and introduction of nonnative fish that prey upon the species.

There have been few transplants into formerly occupied habitats (Table 2). Sonora sucker was successfully repatriated into O'Donnell Creek after that stream was renovated to remove nonnative fish, and was stocked in an artificial channel at a casino/resort in the Phoenix metropolitan area. A single individual stocked by Arizona Game and Fish Department into Arnett Creek did not survive, likely due to the stream drying during an extended drought. Because of the incorrect assumption that Sonora sucker is ubiquitous, no conservation actions directly focused on it have been made except for the transplants (Table 3). Instead, it has benefited indirectly from recovery and conservation actions taken for co-occurring listed species. Protection of existing populations is necessary to prevent its further decline. A program of repatriation into historically occupied habitats is recommended to ensure its continued existence across its range. Additionally, removal of nonnative species from many of its habitats will be required for the species to persist in rivers and larger streams (Table 4). We recommend Sonora sucker be listed under the Endangered Species Act as threatened because of losses from many localities in the Gila River basin, continuing anthropogenic disturbances to its habitats, and chronic impacts of nonnative species. This is consistent with previous recommendations from the Desert Fishes Recovery Team and federal agencies (Minckley 1993, U.S. Fish and Wildlife Service 1994a).

***Catostomus latipinnis* Flannelmouth sucker.** Flannelmouth sucker inhabited the

large, strongly flowing rivers of the Colorado River system, including the Gila, Salt, and San Pedro in Arizona. By the end of the 19<sup>th</sup> century, it had disappeared from the Gila and San Pedro rivers, but persisted in the Salt River into the 1960's (Table 1). It remains in the Colorado River, but with a much-reduced range. Little is known of its biology in the Gila River basin, but see (Minckley 1973b, 1985, Sublette et al. 1990, James 1993, Gido et al. 1997, Weiss et al. 1998, Bezzerides and Bestgen 2002, Mueller and Wydoski 2004, Anon 2004a).

Flannelmouth sucker no longer occurs in the Gila River basin, a result of dewatering, reservoir construction and other habitat alterations, and introduction of nonnative predatory fishes (Chart and Bergersen 1992, Marsh and Douglas 1997). Because the species has disappeared from major portions of the lower Colorado River basin, it is considered to have a high probability of local extirpation (Fagan et al. 2002), and indeed is disappearing from its range elsewhere (Bezzarides and Bestgen 2002)

There have been no efforts to reintroduce flannelmouth sucker into waters of the Gila River basin (Table 2). However, a stocking into the Colorado River to control nuisance aquatic insects near the communities of Bullhead City and Laughlin had the unexpected result of establishing a population (Mueller and Wydoski 2004). A conservation strategy for this species and others has been described for the lower Colorado River (Minckley et al. 2003), and there is an ongoing multi-state effort to formulate management direction for flannelmouth sucker (Anon 2004b) (Table 3). Flannelmouth sucker should be restored to the Gila River basin (Table 4). Because it has disappeared from the basin and is declining elsewhere, we recommend flannelmouth sucker be listed under the Endangered Species Act as endangered. This is consistent with previous recommendations from the Desert Fishes Recovery Team and federal agencies

(Minckley 1993, U.S. Fish and Wildlife Service 1994a).

***Elops affinis* Machete (Pacific tenpounder).** Occurrence of this euryhaline transient in the Gila River probably relates to proclivity to ascend into freshwater and access from the Gulf of California, now denied in most years due to lack of water in the lowermost Colorado River (Minckley 1985, Minckley and Rinne 1991, Bettaso and Young 1999). However, one occurrence of machete in the Gila River was recorded in 1963 (Anon 2003). We found no evidence to show changes in distribution of this species in historical or recent times, although it is probably less abundant in desert rivers than formerly because of decreased flows and barrier dams. There have been no repatriation or translocation attempts (Table 2), and no conservation activities directed at the species (Table 3). Recommendations for conservation activities include restoration of migration routes into the Gila River from the Gulf of California (Table 4).

***Mugil cephalus* Striped mullet.** Striped mullet enters the lower Gila River system relatively frequently as flows in the lower Colorado River allow access from the Gulf of California. It has been recorded as far upstream as Painted Rock flood-retention reservoir in Maricopa County (Table 1). The species typically spawns in the sea, and young individuals move into brackish water to feed and grow. Larger individuals will move further upstream into freshwater when access is available, but return to the sea to reproduce. In modern times, juvenile fish have been in the lower Colorado and Gila rivers, suggesting that spawning is occurring as salinity in those waters rises due to agricultural runoff (Minckley 1973, Bettaso and Young 1999). Their presence in the Gila River is probably a result of proclivity to ascend into freshwater, and access from the Gulf of California, now denied in most years due to lack of water in the lowermost Colorado River (Bettaso and Young 1999). We found no indication that their range in the lower Gila River has diminished either

historically or recently (Minckley 1985, Minckley and Rinne 1991, Anon 2003). There have been no repatriation or translocation attempts (Table 2), nor any conservation activities directed at the species (Table 3). Recommendations for conservation activities include restoration of migration routes into the Gila River from the Gulf of California (Table 4).

***Pantosteus clarki* Desert sucker.** Desert sucker occupies small to medium size mountain streams and creeks in the Gila River basin, and canals of the Phoenix metropolitan area. It occupies a wide range of elevation but achieves its greatest abundance in hard-bottomed streams of intermediate elevation. Historically, it was not recorded from the Gila River downstream of the Salt River. Primitive people along the Verde River used it as food. Information on its biology and ecology can be found in the following manuscripts: Minckley and Alger 1968, Minckley 1973b, 1981, 1985, Fisher 1979, Fisher et al. 1981, Schreiber and Minckley 1981, Wier et al. 1983, Bestgen et al. 1987, Clarkson and Minckley 1988, Ivanyi 1989, Sublette et al. 1990, Rinne 1992, James 1993, U.S. Fish and Wildlife Service 1994, Ivanyi et al. 1995, Mueller 1996, Robinson et al. 1997, Robinson et al. 1998, Stefferud and Stefferud 2003, Eby et al. 2003, Bonar et al. 2004, and Anon 2004a.

Desert sucker remains in 137 (74%) of the 186 locations in which it has been recorded (Table 1). Dewatering and alteration of habitats and introduction of nonnative species have caused its decline throughout its historical range. Because desert sucker has not disappeared from any significant portion of its range, it is considered to have a low probability of local extirpation (Fagan et al. 2002).

There has been one documented repatriation, which failed due to stream desiccation during long-term drought (Table 2). Other activities that indirectly benefited desert sucker were done for recovery of listed species (Table 3). Monitoring of populations

and repatriation into previously occupied habitats should be instituted, and remaining populations protected to ensure maintenance of the species (Table 4). Removal of nonnative fishes from larger streams and rivers will be necessary to ensure the continued existence of the species as an integral part of the native fish assemblage. Because it has disappeared from a large number of localities in the Gila River basin, continuing anthropogenic impacts on its habitats, and nonnative species continually impact individuals through predation, we recommend that desert sucker be listed under the Endangered Species Act as threatened, as previously recommended by others (Minckley 1993, U.S. Fish and Wildlife Service 1994).

***Rhinichthys osculus* Speckled dace.** In the Gila River basin, speckled dace currently occurs in rivers, streams, cienegas, and spring streams up to about 10,000', and it previously occurred in lower elevation rivers down to the Colorado River. Information on its biology and ecology can be found in Chamberlain 1904, John 1963, John 1964, Lowe et al. 1967, Minckley 1973b, Rinne 1975, Minckley 1981, 1985, 1999, Mueller 1984, Meffe and Minckley 1987, Sublette et al. 1990, Rinne 1992, Eby et al. 2003, Oakey et al. 2004, and Anon 2004a.

Speckled dace has been eliminated from most waters below about 3,000', including the Santa Cruz and San Pedro rivers (Table 1). It has also disappeared from many smaller streams and isolated locations that are fragmented from potential sources of recolonization. Reasons for its decline include loss of habitat due to dewatering, introduction of both coldwater and warmwater piscivorous nonnative species, and alteration of habitats. Its decline continues as nonnative fishes invade its range and habitat alterations persist. Within the basin, it was historically recorded in 215 locations, and currently occurs in 153 locations, a decline of 29%. The probability of local extirpation is low (Fagan et al. 2002), likely because it remains widespread throughout its range.

There is one recorded transplant for the species (Table 2). It has benefited from conservation activities done for recovery of listed fishes, but was lost from one system during recovery efforts for a listed species (Table 3). A program of monitoring of existing populations and repatriation into previously occupied waters would serve to decelerate its decline, as would sensitivity in land management activities towards the integrity of habitats (Table 4). Because it has disappeared from a large number of localities in the Gila River basin, habitats continue to be impacted by anthropogenic activities, and nonnative species continue to proliferate, we recommend that speckled dace be listed under the Endangered Species Act as threatened within the Gila River basin. This is consistent with previous recommendations from the Desert Fishes Recovery Team and federal agencies (Minckley 1993, U.S. Fish and Wildlife Service 1994).

## Conclusions

The entire native fish fauna of the Gila River basin is biologically imperiled, as are many other obligate aquatic taxa (Williams et al. 1989, Warren, Jr. and Burr 1994, Arizona Game and Fish Department 1996, U.S. Fish and Wildlife Service 1999a, 1999b, Desert Fishes Team 2003, Clarkson 2004, Clarkson et al. 2004). Nonnative species continue to expand in range and abundance, and habitat deterioration through water development and watershed alteration present a consistent threat to habitats (Miller 1961, Minckley and Deacon 1968, Minckley and Rinne 1991, Tyus and Saunders, III 2000).

Increased attention to the health and vigor of these species and their populations is necessary to prevent a slow but inexorable slide towards loss of metapopulations and local extirpation. We recommend 1) Endangered Species Act protection be extended to longfin dace, Sonora sucker, flannelmouth sucker, desert sucker, and speckled dace, 2) an aggressive program be implemented to convert individual streams and complexes within watersheds to refuges



for native species through barriers, removal of nonnative species, and repatriation of native fishes, 3) anthropogenic factors that negatively affect habitats be modified to reduce impacts on native fishes, and 4) existing populations of native species be protected and systematic monitoring of their populations be implemented. Few successful recovery and conservation actions have occurred during the past several decades for these fish. Technologies and processes exist to improve the status of these species and should be put into practice. Other innovative techniques and applications, such as development and licensing of species-specific piscicides and design of transgenic fishes to eliminate or reduce populations of nonnative species, should be investigated and deployed as appropriate.

Effective leadership on the part of state and federal agencies responsible for species and habitats will be necessary to stem the decline of these species. We encourage attempts to proactively manage these species along with listed endangered and threatened species via a holistically planned, multi-agency program that will benefit the entire assemblage of native fishes and other native aquatic fauna and flora of the Gila River basin.

## **Acknowledgements**

These conclusions and recommendations are the culmination of deliberations of the Desert Fishes Team, an independent group of biologists and individuals interested in protecting and conserving native fishes of the lower Colorado River basin. The Team was formed to fill the void left by the 2002 disbanding by U.S. Fish and Wildlife Service of its Desert Fishes Recovery Team, and includes biologists and participants from U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, University of Arizona, Arizona State University, The Nature Conservancy, independent experts and others, including (in alphabetical order): H. Blasius, R. Calamusso, R. Clarkson, R. Csargo, K. Fitzsimmons, M. Haberstich, P. Marsh, P. Reinthal, J. Rinne, A. Sillas, J. Simms, J. Stefferud, S. Stefferud, A. Telles, A. Unthank, W. Wall, M. Whitney (deceased), and several others whose agencies requested they remain anonymous. The content or opinion expressed in this report does not necessarily represent views, policies, or official positions of any other entity, including agencies or organizations that may employ Team participants.

**Table 1. Historical (1840-1979) and modern (1980-2003) distributions by water and county for non-listed warm water fishes in the Gila River basin, Arizona, New Mexico, and Sonora. “M” designates records confirmed by museum collections, “X” designates occurrence records from literature, reports, field notes, personal communications that are not confirmed by museum collections, “O” designates assumed presence pre-1979 based on post-1980 occurrence, and “I” designates artificial translocation. (Table 1a = longfin dace, Sonora sucker, desert sucker, and speckled dace. Table 1b = flannelmouth sucker, striped mullet, and machete).**

<u>Table 1a.</u>		<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
Water	County	1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003
ARIZONA									
Agua Fria River	Maricopa	O	M	O	X				
Agua Fria River	Yavapai	M	M			M	M		
Alder Creek	Greenlee			O	M			O	M
Alder Creek	Maricopa							X	
Alum Gulch	Sta. Cruz							X	
Apache Creek	Gila			X					
Apache Creek	Greenlee	X							
Apache Creek	Yavapai							M	M
Apache Lake	Gila			M		M			
Apache Lake	Maricopa					X			
Aravaipa Creek	Graham			M	M	M	M	M	M
Aravaipa Creek	Pinal	M	M	M	M	M	M	M	M
Arrastre Creek	Yavapai	O	M			O	M		
Artificial channel, Wild Horse Pass Casino	Maricopa				I				
Ash Creek	Graham	O	M	M					
Ash Creek	Greenlee	O	M					O	M
Ash Creek	Yavapai	O	M			O	M	X	M
Babocomari Cienega	Cochise			M	M				
Babocomari River	Cochise	M	M			M	M	M	
Badger Spring	Yavapai	O	M						
Bain Spring	Yavapai	O	M			O	M		
Basin Creek	Apache							X	
Bass Canyon	Cochise	O	M	O	M	M	M	M	M
Bear Canyon	Greenlee	O	X			O	M	M	M
Bear Canyon	Pinal	O	M						
Bear Canyon Creek	Greenlee	O	M					X	X
Bear Creek	Cochise	M	M						
Bear Wallow Creek	Greenlee							M	M
Beaver Creek	Greenlee			M		M		M	
Beaver Creek	Yavapai	M		M		M		M	
Big Bonito Creek	Apache			M		M		M	
Big Bug Creek	Yavapai	M	M	M		X	M		
Big Chino Wash	Yavapai			M				X	
Binghampton Pond	Pima	M							
Black Canyon	Yavapai	O	M						
Black River	Apache			M		M	M	M	M
Black River	Gila			M	M	M			
Black River	Graham			X		M		M	
Black River, EF	Apache			M		M		M	







Water	County	<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
		1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003
Johnson Spring	Sta. Cruz	O	M						
Kayler Spring	Gila	O	M	O	M	O	M	O	M
Knipe Cienega near Canelo	Sta. Cruz	M							
KP Creek	Greenlee			O	M	O	M	O	M
Lampshire Canyon	Sta. Cruz	O	X						
Lanphier Canyon	Greenlee	O	M	O	M			O	X
Lewis Creek	Gila	M							
Lime Creek	Maricopa	M	M			M			
Lime Creek	Yavapai	X	M						
Little Ash Creek	Yavapai	M	M			M	M	M	M
Little Blue Creek	Greenlee	O	M			O	M	O	M
Little Blue River	Greenlee	O	M	O	M	O	M	O	M
Little Bonito Creek	Apache							X	M
Little Colorado River	Apache							O	X
Little Colorado River, EF	Apache							O	X
Little Colorado River, SF	Apache							X	X
Little Creek	Apache			X				M	
Little Dutch Blue Creek	Greenlee	M						M	
Little Sycamore Creek	Yavapai	X	M			X	M	O	M
Lone Mountain Canyon	Cochise	O	X						
Markam Creek	Graham	O	M					O	M
Martinez Canyon	Pinal	O	M						I
Martinez Creek	Gila							O	X
Mattie Canyon	Pima	O	M						
Mescal Creek	Gila	O	M						
Midvale Farms Irrigation system	Pima	X							
Milk Creek	Yavapai	O	M			O	M		
Mineral Creek	Pinal	M	M			O	M		
Minnehaha Creek	Yavapai	O	M						
Mint Wash	Yavapai	O	M						
Mustang Tank drainage	Yavapai	O	M						
Natural Bridge Creek	Apache							X	
Neighbor Spring	Sta. Cruz	O	X						
New River	Maricopa	M	M						
New River	Yavapai	O	X						
Nogales Wash	Sta. Cruz	O	M			O	M		
Nutrioso Creek	Apache							X	X
O'Donnell Canyon	Sta. Cruz	M	M	M	M				
Oak Creek	Coconino			M	M	M	M	M	M
Oak Creek	Greenlee	O	M	O	M			O	M
Oak Creek (Hassayampa)	Yavapai	O	M			X			
Oak Creek (Verde)	Yavapai	M	M	M	M	M	M	X	
Oak Creek, WF	Yavapai							X	
Oak Grove Canyon	Graham	O	M	O	M	O	M	X	M
Oak Grove Canyon	Sta. Cruz	O	M						
Open Draw Creek	Apache					O	M	O	M
Paddy Creek	Apache							O	X
Padre Creek	Yuma							X	
Parker Canyon	Cochise	O	M						
Peck Canyon	Sta. Cruz	M	M						

Water	County	<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
		1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003
Pena Blanca Canyon	Sta. Cruz	X							
Pena Blanca Springs	Sta. Cruz	M							
Picacho Reservoir	Pinal			M		M			
Pinal Creek	Gila			M				M	
Pine Creek	Gila					M			
Pinto Creek	Gila	M	M			M	M		
Pinto Creek, WF	Pinal	O	M			O	M		
Pipestream Creek	Greenlee	O	M						
Potero Creek	Sta. Cruz	M							
Raspberry Creek	Greenlee	M	M			M		M	M
Red Creek	Yavapai	M	M			M	M		
Red Tank Draw	Yavapai			O	M	O	M		
Redfield Canyon	Graham	M	M	M	M	O	M	M	M
Redrock Canyon	Sta. Cruz	M	M			O	M	O	X
Reservation Creek	Apache					M		M	
Reynolds Creek	Gila	O	M						
Rock Creek	Coconino							X	
Rock Creek	Gila					O	M	O	M
Rock Creek	Maricopa	O	X						
Rock Spring #3	Maricopa	O	M						
Roosevelt Lake	Gila			M	M	M			
Round Valley Spring	Yavapai							O	M
Roundtree Canyon	Yavapai	O	X						
Rucker Canyon	Cochise	O	X						
Rudd Creek	Apache							O	X
Rye Creek	Gila	M	M	M	M	M	M	M	M
Sabino Canyon Creek	Pima	M	X						
Salome Creek	Gila	O	M	O	M				
Salt Creek	Gila	M		X	X	X	X	X	X
Salt Creek	Graham	M							
Salt Creek Draw	Gila	M		M					
Salt River	Gila	M	M	M	M	M	M	M	M
Salt River	Maricopa	M	M	M	M	M	M	M	
Salt River Project canals	Maricopa	M	M	X	M	M	M		
San Carlos Lake	Gila			M					
San Carlos River	Gila	M				M			
San Francisco River	Apache							M	
San Francisco River	Gila			X					
San Francisco River	Greenlee	O	M	M	M	M	M	O	M
San Pedro Creek	Cochise	X							
San Pedro River	Cochise	M	M	M		M	M	M	
San Pedro River	Pinal	M	M	M	M	O	M	M	
Santa Cruz River	Pima	M		M		M			
Santa Cruz River	Sta. Cruz	M	M	M	M	M	M	M	
Sardine Canyon	Greenlee	O	M					O	M
Sardine Creek	Greenlee			O	M			O	M
Seven Springs Wash	Maricopa	I	I					M	
Sharp Spring Tank	Sta. Cruz	O	M						
Sheehy Spring	Sta. Cruz	M							
Sheep Creek	Maricopa	O	M						

Water	County	<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
		1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003
Silver Creek	Yavapai	X	M			O	M		
Snake Creek	Apache	M							
Snake Creek	Greenlee							M	M
Soldier Hole Spring	Graham							O	M
Sonoita Creek	Sta. Cruz	M	M	M	M	M	M	M	M
Spring Canyon	Graham	O	M						
Spring Creek	Gila					M	M	M	M
Spring Creek	Yavapai	X	M	O	M	O	M	X	M
Spruce Creek Canyon Del Muerto	Apache							X	
Squaw Creek	Greenlee							O	M
SRP Arizona Canal	Maricopa	O	M						
SRP Consolidated Canal	Maricopa	M							
SRP Mesa Consolidated Canal	Maricopa	M							
SRP Tempe Canal	Maricopa	M							
Stinky Creek	Apache					M	M	M	M
Strayhorse Creek	Greenlee	M	M			M	X	M	M
Swamp Spring	Graham	O	M						
Swamp Springs Canyon	Graham	M							
Sycamore Canyon	Cochise	X	X						
Sycamore Creek	Maricopa	M	M	O	M	M	M	M	
Sycamore Creek (Agua Fria)	Yavapai	M				M	M		
Sycamore Creek (Verde)	Yavapai	M	M	M	M	M	M	M	M
T.T. Spring	Yavapai	O	M						
T4 Spring	Cochise	M	M	M					
Tangle Creek	Yavapai	O	M						
Temporal Gulch	Sta. Cruz	O	M			O	M	O	M
Thicket Spring	Yavapai	O	M						
Thomas Creek	Greenlee	O	M					M	M
Thompson Creek	Apache	O	M					O	M
Tonto Creek	Apache					M		M	X
Tonto Creek	Gila	M	M	M	M	M	M	M	X
Tsaile Creek	Apache							X	
Tule Creek	Yavapai	O	M						
Turkey Creek	Graham	M	M	M	M	O	M	M	M
Turkey Creek	Greenlee	O	M	O	M	O	M	O	M
Turkey Creek	Sta. Cruz	M	M						
Turkey Creek, SF	Cochise							X	
Unnamed Spring #0	Maricopa	O	M						
Unnamed spring in W L Pleasant	Maricopa	X							
Unnamed Spring Red Creek	Yavapai	O	X						
Unnamed stream Robinson Mesa	Greenlee	O	X						
Verde River	Gila-Yavapai	X	M	O	M	O	M		
Verde River	Maricopa	M	M	M	M	M	M		
Verde River	Yavapai	M	M	M	M	M	M	M	M
Virgus Canyon	Pinal			M					
Walker Creek	Yavapai					O	M	M	M
Walnut Canyon	Pinal	O	M						
Walnut Creek, SF	Yavapai							O	M
Webber Creek	Gila					M		M	
West Clear Creek	Coconino					M		M	



Table 1a.		<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
Water	County	1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003	1840- 1979	1980- 2003
West Clear Creek	Yavapai	M	M	M	X	M	M	M	M
West Turkey Creek	Cochise	O	X						
			X						
Wet Beaver Creek	Yavapai	M		M	M	M	X		
Wet Bottom Creek	Gila	M				M			
Wheatfields Creek	Apache							X	
Whiskey Creek	Apache							X	
White River	Gila			M	M	M	M	M	M
White River	Navajo			X	X	X	X	M	X
White River, EF	Apache					M			
White River, EF	Navajo			O	M	O	M	O	M
White River, NF	Apache			M		M		M	M
White River, NF	Navajo			O	M	M	M	O	X
White Rock Spring	Yavapai	O	M						
Wildcat Canyon	Cochise	O	M					X	M
Wildcat Creek	Apache							X	
Williamson Valley Creek	Yavapai	O	M						
Willow Creek	Greenlee	O	M	O	M	O	M	M	M
Willow Tank Canyon	Greenlee	O	M	O	M	O	M	O	M
Yankee Joe Canyon	Gila	O	M						
Yellow Jacket Creek	Yavapai	O	M			O	M		
Zig Zag Spring	Yavapai	O	M						
<b>NEW MEXICO</b>									
Apache Creek	Catron	M				M		M	
Big Dry Creek	Catron	O	X						
Black Canyon Creek	Grant	O	X	M	X	M	X	M	X
Centerfire Creek	Catron	X	X						
Dry Blue River	Catron	O	M			O	X	O	M
Frieborn Canyon	Catron							O	M
Frisco Hot Springs	Catron	M		M		M		O	M
Gila River	Catron	M	M	O	X	X	X	M	X
Gila River	Grant	M	M	M	M	M	M	M	X
Gila River	Hidalgo	M	M	X		M	X		
Gila River, EF	Catron	M	M	M	M	M	M	M	M
Gila River, EF	Grant	M	M	M	M			M	M
Gila River, EF	Sierra	M	M			X			
Gila River, MF	Catron	M	M	M	M	M	M	M	M
Gila River, WF	Catron	M	M	M	M	M	M	M	M
Gila River, WF	Grant	M	M	M	M	M		M	M
Little Creek	Grant	O	X	O	X	O	X	X	X
Main Diamond Creek	Sierra	O	X	O	X	O	X	O	X
Mangus Creek	Grant	M	M	M	M	M	M		
Mogollon Creek	Grant	M						X	
Mule Creek	Grant	O	X	X		X	X	O	X
Negrito Creek	Catron	M				M			
Negrito Creek, SF	Catron	O	M	X	M	M		O	M
Pace Creek	Catron	O	M					O	M
Rocky Canyon	Grant	X	X						
Romero Creek	Catron					O	X	O	X

**Table 1a.**

Water	County	<i>A. chrysogaster</i> Longfin dace		<i>C. insignis</i> Sonora sucker		<i>P. clarki</i> Desert sucker		<i>R. osculus</i> Speckled dace	
		1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003
San Francisco River	Catron	M	M	M	M	M	M	M	M
Sapillo Creek	Grant	M				M			
Snow Creek	Catron			M				M	
Taylor Creek	Catron			M					
Trout Creek	Catron				X	O	X	O	X
Tularosa River	Catron	M	M	M	M	M	M	M	M
Turkey Creek	Grant	M	X	O	M	X			
Unnamed tributary Mule Creek	Grant	O	X						
White Creek	Catron			X	X	X	X	O	X
Whitewater Creek	Catron	M	M	M	X	M		M	
Willow Creek	Catron					M	X	M	
<b>SONORA</b>									
Los Fresnos	Sonora	O	X						
San Pedro River	Sonora	M	X			O	X		
Santa Cruz River	Sonora	M	X	O	X	M	X		

**Table 1b.**

Water	County	<i>C. latipinnis</i> Flannelmouth sucker		<i>E. affinis</i> Machete		<i>M. cephalus</i> Striped mullet	
		1840-1979	1980-2003	1840-1979	1980-2003	1840-1979	1980-2003
<b>ARIZONA</b>							
Cibecue Creek	Gila	M					
Gila River	Gila	M					
Gila River	Graham	M					
Gila River	Maricopa					X	M
Gila River	Pinal	X					
Gila River	Yuma			M		M	M
Pinal Creek	Gila	M					
Salt River	Gila	M					
Salt River	Maricopa	M					
San Carlos Lake	Gila	M					
San Pedro River	Cochise	M					
San Pedro River	Pima	X					
San Pedro River	Pinal	X					

**Table 2. Status of transplant and repatriation activities for non-listed warm water fishes in the Gila River basin, Arizona and New Mexico done by U.S. Fish and Wildlife Service (USFWS), Arizona Game and Fish Department (AZGFD), or New Mexico Department of Game and Fish (NMDGF) since 1967. Counties are identified for waters not listed in Table 1, or for waters or names that occur in more than one county.**

Species	Successful population establishment	Unsuccessful population establishment
<i>A. chrysogaster</i> Longfin dace	-Martinez Canyon from Aravaipa Canyon, May 2002, June 2004 -Empire Gulch from Cienega Creek near confluence with Mattie Canyon, Las Cienegas, October 2001 -Cave Creek, Maricopa Co., from Bill Williams and Hassayama rivers, unknown county, before 1966	-Arnett Creek, from Gila River near Kearny-Winkleman, Pinal Co., February 2002. Failure due to stream drying.
<i>C. insignis</i> Sonora sucker	-O'Donnell Creek, from same site stock salvaged before stream renovation, 2002 -Artificial channel at Wild Horse Pass Casino, Maricopa Co., from SRP canal, Maricopa Co., 2004	-Arnett Creek, from Gila River near Kearny-Winkleman, February 2002. Failure due to stream drying.
<i>C. latipinnis</i> Flannelmouth sucker	-None documented	-None documented
<i>E. affinis</i> Machete	-None documented	-None documented
<i>M. cephalus</i> Striped mullet	-None documented	-None documented
<i>P. clarki</i> Desert sucker	-None documented	-Arnett Creek, from Gila River near Kearny-Winkleman, February 2002. Failure due to stream drying.
<i>R. osculus</i> Speckled dace	-Martinez Canyon from Aravaipa Canyon, June 2004	-Seven Springs Wash, from Camp Creek. Stock salvaged before stream renovation in 1971. Reason for failure unknown.

**Table 3. Recovery and conservation activities (post-1967) for non-listed warm water fishes in the Gila River basin (recovery activities are those that directly benefit the species, e.g., increase its range and/or abundance, exclusive of stockings. Conservation activities are those that indirectly benefit the species, but may not produce immediately discernable effects, e.g., habitat improvement. Other activities ongoing or that have occurred in other parts of the native range of these species are not considered in this document. Abundant literature is available for each species, and the citations provided are only a few pertinent manuscripts.) Counties are identified for waters not listed in Table 1, or for waters or names that occur in more than one county.**

Table 3.			
Species	Recovery activities excluding transplants/repatriations	Conservation activities	Monitoring, surveys, captive populations, and research activities
<i>A. chrysogaster</i> Longfin dace	<ul style="list-style-type: none"> <li>-Arnett Creek Barrier and renovations</li> <li>-Aravaipa Creek barriers</li> <li>-Proposed Bonita Creek Barrier</li> <li>-O'Donnell Creek renovation</li> <li>-Cienega Creek habitat reconstruction and dam removal</li> <li>-Upper Sonoita Creek railroad abutment removal</li> <li>-Renovation and restoration of native fish assemblage in Fossil Creek (pending)</li> <li>-Cottonwood Spring, Santa Cruz Co., barrier</li> </ul>	<ul style="list-style-type: none"> <li>-Decommissioning of Childs/Irving hydropower facility (pending)</li> <li>-Livestock grazing improvements (upper Gila River)</li> <li>-Nonnative threat control (restrictions on live bait fish use and increased bag limits in AZ)</li> <li>-Crayfish trapping in Fossil Creek, Martinez Canyon, and Cave Creek</li> <li>-Cienega Creek basin closed to angling.</li> <li>-Acquisition and management of San Pedro River Riparian National Resource Area</li> <li>-Acquisition and management of properties along Aravaipa, O'Donnell, and Sonoita creeks, and San Pedro and Hassayampa rivers (Arizona), and Gila River (New Mexico) by The Nature Conservancy</li> <li>-Acquisition and management of properties along Cave Creek (Maricopa Co.) by the Desert Foothills Land Trust</li> <li>-Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</li> <li>-Road and bridge activities cancelled or altered (East Fork Gila River road development, Romero Road bridge relocation on San Pedro, Aravaipa bridge)</li> <li>-Livestock grazing improvements (exclusion of river on upper Verde, portions of Gila in NM, Aravaipa Creek BLM lands, parts of Eagle Creek, Bonita Creek on BLM)</li> </ul>	<ul style="list-style-type: none"> <li>-Annual monitoring in Eagle and Aravaipa creeks, upper Verde, Gila, San Pedro, and Salt rivers, SRP, CAP, and Florence-Casa Grande canals, Arizona.</li> <li>-Annual monitoring in Tularosa, Gila, and San Francisco rivers (New Mexico)</li>   <li>(Minckley 1969, Minckley and Barber 1971, Schreiber and Minckley 1981)</li> </ul>
<i>C. insignis</i> Sonora sucker	<ul style="list-style-type: none"> <li>-Renovation and restoration of native fish assemblage in Fossil Creek (pending)</li> <li>-Aravaipa Creek barriers</li> </ul>	<ul style="list-style-type: none"> <li>-Decommissioning of Childs/Irving hydropower facility (pending)</li> <li>-Nonnative threat control (restrictions on live bait fish use and increased bag limits in AZ)</li> </ul>	<ul style="list-style-type: none"> <li>-Annual monitoring in Eagle and Aravaipa creeks, upper Verde, Gila, San Pedro, and Salt rivers, SRP, CAP, and Florence-Casa Grande canals, Arizona.</li> <li>-Annual monitoring in Tularosa,</li> </ul>

Table 3.

Species	Recovery activities excluding transplants/repatriations	Conservation activities	Monitoring, surveys, captive populations, and research activities
		<ul style="list-style-type: none"> <li>-Crayfish trapping in Fossil Creek</li> <li>-Acquisition and management of properties along Aravaipa, O'Donnell, and Sonoita creeks (Arizona), and Gila River (New Mexico) by The Nature Conservancy</li> <li>-Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</li> <li>-Road and bridge activities cancelled or altered (East Fork Gila River road development, Romero Road bridge relocation on San Pedro, Aravaipa bridge)</li> <li>-Livestock grazing improvements (exclusion of river on upper Verde, portions of Gila in NM, Aravaipa Creek BLM lands, parts of Eagle Creek, Bonita Creek on BLM)</li> </ul>	Gila, and San Francisco rivers (New Mexico)
<i>C. latipinnis</i> Flannelmouth sucker	-None documented	- In-progress: "Range-wide conservation agreement and strategy for 3 species"	<ul style="list-style-type: none"> <li>-status reviews: (Bezerides and Bestgen 2002)</li> <li>-biological studies: (Weiss et al. 1998, Clarkson and Childs 2000)</li> <li>-genetic studies: (Douglas et al. 2003)(Dobberfuhr 1995)</li> </ul>
<i>E. affinis</i> Machete	-None documented	-None documented	
<i>M. cephalus</i> Striped mullet	-None documented	-None documented	
<i>P. clarki</i> Desert sucker	<ul style="list-style-type: none"> <li>-Renovation and restoration of native fish assemblage in Fossil Creek (pending)</li> <li>-Aravaipa Creek barriers</li> </ul>	<ul style="list-style-type: none"> <li>-Decommissioning of Childs/Irving hydropower facility (pending)</li> <li>-Nonnative threat control (restrictions on live bait fish use and increased bag limits in AZ)</li> <li>-Crayfish trapping in Fossil Creek</li> <li>-Acquisition and management of San Pedro River Riparian National Resource Area</li> <li>-Acquisition and management of properties along Aravaipa and Sonoita creeks, and San Pedro and Hassayampa rivers (Arizona), and Gila River (New Mexico) by The Nature Conservancy</li> <li>-Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</li> <li>-Road and bridge activities cancelled or altered (East Fork Gila River road development, Romero Road bridge relocation on San Pedro, Aravaipa bridge)</li> <li>-Livestock grazing</li> </ul>	<ul style="list-style-type: none"> <li>-Annual monitoring in Eagle and Aravaipa creeks, upper Verde, Gila, San Pedro, and Salt rivers, SRP, CAP, and Florence-Casa Grande canals, Arizona.</li> <li>-Annual monitoring in Tularosa, Gila, and San Francisco rivers (New Mexico)</li> </ul>

Table 3.

Species	Recovery activities excluding transplants/repatriations	Conservation activities	Monitoring, surveys, captive populations, and research activities
<i>R. osculus</i> Speckled dace	<ul style="list-style-type: none"> <li>-Upper Sonoita Creek railroad abutment removal</li> <li>-Renovation and restoration of native fish assemblage in Fossil Creek (pending)</li> <li>-Renovation of Seven Springs Wash to remove longfin dace, project failed and speckled dace were eliminated from site</li> <li>-Aravaipa Creek barriers</li> </ul>	<p>improvements (exclusion of river on upper Verde, portions of Gila in NM, Aravaipa Creek BLM lands, parts of Eagle Creek, Bonita Creek on BLM)</p> <ul style="list-style-type: none"> <li>-Decommissioning of Childs/Irving hydropower facility (pending)</li> <li>-Nonnative threat control (restrictions on live bait fish use and increased bag limits in AZ)</li> <li>-Crayfish trapping in Fossil Creek and Big Springs drainage</li> <li>-Acquisition and management of properties along Aravaipa and Sonoita creeks, and San Pedro River (Arizona), and Gila River (New Mexico) by The Nature Conservancy</li> <li>-Acquisition and management of properties along Cave Creek (Maricopa Co.) by the Desert Foothills Land Trust</li> <li>-Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</li> <li>-Road and bridge activities cancelled or altered (East Fork Gila River road development, Romero Road bridge relocation on San Pedro, Aravaipa bridge)</li> <li>-Livestock grazing improvements (exclusion of river on upper Verde, portions of Gila in NM, Aravaipa Creek BLM lands, parts of Eagle Creek, Bonita Creek on BLM)</li> </ul>	<ul style="list-style-type: none"> <li>-Annual monitoring in Eagle and Aravaipa creeks, upper Verde, Gila, San Pedro, and Salt rivers, SRP, CAP, and Florence-Casa Grande canals, Arizona (Rinne et al., in press, Marsh et al. 1990, Clarkson 2001)</li> <li>-Annual monitoring in Tularosa, Gila, and San Francisco rivers (New Mexico) (Propst 2002)</li> <li>-Research on propagation, 1998</li> <li>-Research on genetics (Oakey et al. 2004)</li> </ul>

**Table 4. Recommendations for transplants and replications, and conservations actions for non-listed warmwater fishes in the Gila River basin. Counties are identified for waters not listed in Table 1, or for waters or names that occur in more than one county.**

Table 4.		
Species	Recommended replication sites (not an exhaustive listing)	Recommendations for conservation actions
<i>A. chrysogaster</i> Longfin dace	-Repatriate to extirpated waters, as suitable. Immediate opportunities include, but are not limited to: -Alamo Canyon (Sta. Cruz Co.) -Arnett Creek -Bingham Cienega (Pima Co.) -O'Donnell Creek -Post Canyon (Sta. Cruz Co.) -Sabino Canyon -Scotia Canyon (Cochise Co.) -Sheehy Spring -Turkey Creek (Sta. Cruz Co.)	-Remove nonnative fishes from habitats needed by species -Continue systematic monitoring and comprehensive reporting, and expand to other waters as appropriate and needed -Construct barrier in Fossil Creek -Renovate Fossil Creek -Construct barrier in Bonita Creek -Re-stock Arnett Creek -Construct barriers, remove nonnative fishes, and restock into Cave, Sycamore, Lone Mountain canyons, Bear and Joaquin creeks (Cochise Co.) -Construct barrier on Temporal Gulch -Work with Desert Foothills Land Trust, Maricopa Co. Parks, and Tonto National Forest to remove nonnative fishes from Cave Creek -Federal listing as Threatened
<i>C. insignis</i> Sonora sucker	-Repatriate to extirpated waters, as suitable. Immediate opportunities include, but are not limited to: -Arnett Creek -Hassayampa River -San Pedro River -Turkey Creek (Sta. Cruz Co.)	-Remove nonnative fishes from habitats needed by species -Continue systematic monitoring and comprehensive reporting, and expand to other waters as appropriate and needed -Construct barrier in Fossil Creek -Renovate Fossil Creek -Restore into Turkey Creek (Sta. Cruz Co.) -Federal listing as Threatened
<i>C. latipinnis</i> Flannelmouth sucker	-Suitable waters in Gila River basin	-Finalize and implement "Range-wide conservation agreement and strategy for 3 species" -Remove nonnative fishes from habitats needed by species -Restore into appropriate waters in Gila River basin -Federal listing as Endangered in lower Colorado River basin
<i>Elops affinis</i> Machete	-No recommendations	-Ensure waters of lower Gila and Colorado rivers remain connected with Gulf of California -Allow adequate flows of good-quality water to reach the sea -Limit the numbers of nonnative fishes in the river -Remove dams and other barriers in the river
<i>M. cephalus</i> Striped mullet	-No recommendations	-Ensure waters of lower Gila and Colorado rivers remain connected with Gulf of California -Allow adequate flows of good-quality water to reach the sea -Limit the numbers of nonnative fishes in the river -Remove dams and other barriers in the river
<i>P. clarki</i> Desert sucker	-Repatriate to extirpated waters, as suitable. Immediate opportunities include, but are not limited to: -Arnett Creek -Cave Creek (Cochise Co.)	-Remove nonnative fishes from habitats needed by species -Continue systematic monitoring and comprehensive reporting, and expand to other waters as appropriate and needed -Construct barrier in Fossil Creek -Renovate Fossil Creek -Construct barrier on Temporal Gulch -Federal listing as Threatened

Table 4.

<b>Species</b>	<b>Recommended replication sites (not an exhaustive listing)</b>	<b>Recommendations for conservation actions</b>
<i>R. osculus</i> Speckled dace	-Repatriate to extirpated waters, as suitable. Immediate opportunities include, but are not limited to: -Arnett Creek -Buehman Canyon -San Pedro River -Seven Springs Wash	-Remove nonnative fishes from habitats needed by species -Continue systematic monitoring and comprehensive reporting, and expand to other waters as appropriate and needed -Construct barrier in Fossil Creek -Renovate Fossil Creek -Construct barrier on Temporal Gulch -Work with Desert Foothills Land Trust, Maricopa Co. Parks, and Tonto National Forest to remove nonnative fishes from Cave Creek -Federal listing as Threatened



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