STATUS OF FEDERAL- AND STATE-LISTED FISHES OF THE GILA RIVER BASIN, WITH RECOMMENDATIONS FOR MANAGEMENT

Desert Fishes Team

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Report Number 1

October 15, 2003
EXECUTIVE SUMMARY

Purpose: This report reviews the status of the 12 federal- and state-listed fishes in the Gila River basin (excluding trouts) and the post-1967 recovery and conservation actions taken by all agencies, organizations, or parties. The report includes recommendations for future actions for each species.

Organization: Table 1 describes historic range, known extirpations, and remaining populations of each species. Table 2 describes repatriation efforts and their success. Recovery and conservation actions are provided in Table 3. Table 4 contains recommendations for further transplants and repatriations, and recovery and conservation actions. A summary for each species is given in the text.

Conclusions: Status of all 12 species has declined since their original listing and decline is continuing. Few successful recovery and conservation actions have occurred during the 36-year period assessed. Although repatriation has been the primary recovery effort, it has occurred for only a few of the species, and with limited success.

Recommendations: All of these species have existing and adequate recovery plans, but most plan recommendations have not been implemented. Additional planning is unnecessary. On-the-ground implementation of recovery plan actions is paramount to conservation and recovery of the species. Although innovative new strategies are important, existing recovery and conservation strategies and techniques would, if implemented, contribute substantially to stemming the decline of these 12 fish species.
Like the entire indigenous fish fauna of the American southwest, the native fishes of the Gila River watershed (Basin) in central Arizona, southwest New Mexico, and northern Sonora, Mexico, are critically imperiled. In this report, we assess the status of the twelve federal- and state-listed species of the Basin. Our assessment concludes that the status of all of these species has continued to decline notwithstanding federal and state protection. Conservation and recovery efforts have been limited in number and scope, and of little long-term effectiveness in stemming declines of these species.

Reasons for decline of these species are well documented in published literature and recovery plans. Introduction and spread of nonnative aquatic species has been and 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. At present, 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 Basin.

Following this introduction is a brief summary narrative for each species, which is based upon information detailed in the accompanying tables. Historic distribution, known extirpated, and remaining extant populations of these species are in Table 1. Accomplishments to date in establishing transplanted or replication populations are in Table 2. Recovery, conservation, and other activities for these twelve species are in Table 3. Also included are recommendations for sites for establishment of replication populations. The list of replication sites is not inclusive and other suitable replications sites likely exist, particularly for some species, such as Gila topminnow. Table 4 includes suggestions and recommendations for additional activities. A literature cited section completes the report—it provides examples of supporting documentation, but is not comprehensive.

These conclusions and recommendations are the culmination of deliberations of the Desert Fishes Team (Team), an independent group of biologists and parties 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, Bureau of Reclamation, Bureau of Land Management, University of Arizona, Arizona State University, The Nature Conservancy, independent experts, and others. We anticipate continuing the status review effort and expanding it to other lower Colorado River basin fishes and updating periodically, as needed.

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1 The Gila River basin has 20 native fish species. In addition to the 12 species considered here, two native trouts are also Federal- and State-listed. Because they are the only cold-water species, and because as game species they have distinctly separate and more active recovery and conservation programs, we chose not to include them in this status report.
The information used in this report was gathered from many sources, including published and other documents, and the collective work, knowledge, and expertise of participants. There may be additional limited information in the possession of agencies that was not made available for this effort. The information provided in the text and tables is offered in the hope it will assist the agencies and others in initiating and improving recovery and conservation efforts for these 12 highly imperiled and declining fishes.

**Cyprinodon arcuatus Santa Cruz (Monkey Spring) pupfish**  This species is extinct. Once locally abundant in the upper Santa Cruz River drainage, the last population perished in 1971.

**Cyprinodon macularius Desert pupfish**  Historically widespread in the lower Basin, no wild populations of the endangered desert pupfish remain in the Basin. It was transplanted to more than a dozen wild locations, only two of which are still occupied. No additional recovery action has occurred for this species. We recommend additional transplants to suitable wild sites and implementation of the existing recovery plan. Evaluation of transplants of this species into the Santa Cruz River basin in lieu of the extinct Santa Cruz (Monkey Spring) pupfish is recommended.

**Gila elegans Bonyn tail**  The endangered bonytail formerly penetrated far upstream in main stem rivers of the Basin, but has been absent for many decades. No recovery or conservation activities for bonytail have occurred in the Basin. We recommend implementation of the recovery plan and repatriation of bonytail to selected reaches of the upper Gila River.

**Gila intermedia Gila chub**  Proposed as an endangered species, Gila chub remains in fewer than 30 small isolated waters throughout the Basin, which represent only a fraction of the historical range of the species. Two successful transplants are known. Recent renovations to remove nonnative fish in two streams, with subsequent restocking of Gila chub have occurred, however wildfire eliminated one of those populations. We recommend replicating a portion of the remaining wild populations into protected waters, expedited federal listing of the species with critical habitat, and development of a biologically based recovery plan.

**Gila nigra Headwater chub**  A state-listed species, and petitioned for federal listing, headwater chub occurs in fewer than 20 wild locations. The species formerly occupied middle to headwater reaches of middle-size tributary streams in the Verde, Tonto, San Carlos, and upper Gila (New Mexico) drainages. No transplants are documented. Management activities have consisted only of changes in angling regulations. Removal of nonnative fishes from occupied habitats is recommended, as is reestablishment in formerly occupied waters. This species is deserving of protection under the federal Endangered Species Act.

**Gila robusta Roundtail chub**  Roundtail chub has been petitioned for federal listing as endangered, is state-listed in New Mexico and Arizona, and is designated a sport species in Arizona. The species is extirpated from most main stem rivers of the Basin, and currently resides in fewer than 20 tributary streams. Fish barriers recently constructed on Aravaipa Creek have been the only management action to directly benefit the species. Protective conservation actions such as changes in angling regulations, protective fencing of streamsides, land acquisition, and cancellation or alteration of water development projects has occurred. Nonnative species should be removed from occupied habitats. The species is deserving of protection under the federal Endangered Species Act.

**Meda fulgida Spikedace**  Spikedace is federally listed as threatened. Available
data justify up listing the spikedace to federally endangered status, and a petition for up listing has been found warranted. Of all the Basin species, spikedace is probably the most vulnerable to extinction at this time. Populations remain in only seven locations from an original distribution throughout the Basin in suitable habitats in low and intermediate streams. There have been no successful transplants or repatriations. The only recovery activity taken to-date is the construction of barriers to nonnative fish invasion in Aravaipa Creek. Several conservation actions have been taken to remove or prevent increased threats to spikedace, most notably exclusion of livestock grazing from some occupied streams and their riparian corridors. We recommend several replication sites and implementing the existing recovery plan.

**Plagopterus argentissimus Woundfin**  
This federally endangered species was historically found in the Salt, Verde, and Gila rivers, but it now is extirpated from the Basin. Although certain waters were designated for stocking as experimental-nonessential, these actions were never implemented. We recommend revocation of the experimental-nonessential rule because its implementation would not assist in recovery of the species. We advocate transplants and repatriations into appropriate historical habitat with full protection of the Endangered Species Act.

**Poeciliopsis occidentalis Gila topminnow**  
Logistically, the endangered Gila topminnow could be the easiest species in the Basin to recover. Once the most abundant fish in the lower Gila River, it now is restricted to fewer than a dozen small, isolated natural sites. Efforts to reestablish it at about 175 wild locations have resulted in about two dozen established populations. Recovery efforts have included barrier construction, nonnative fish removal, land acquisition, habitat restoration and protection, and threat amelioration at several sites. We recommend aggressive re-implementation of the stocking program, and approval and implementation of the recovery plan that has been in draft status for several years.

**Ptychocheilus lucius Colorado squawfish**  
The top predator in the Basin, this minnow that could achieve 6 feet in length has been eliminated from the Gila River. An endangered species, the core of its Basin range has been designated experimental-nonessential. Nearly 20 years of extensive repatriation efforts have not resulted in reestablishment of the species. Recovery activities have been limited to stocking and changes in angling regulations. We recommend the experimental-nonessential rule be revoked because its implementation would not assist in recovery of the species. We recommend active incorporation of the Basin into ongoing recovery efforts for the species.

**Tiaroga cobitis Loach minnow**  
Loach minnow is federally listed as threatened. Available data justify up-listing the loach minnow to federally endangered status, and a petition for up-listing has been found warranted. Loach minnow remains in fewer than a dozen locations from an original distribution in suitable habitats in low to high elevation streams throughout the Basin. There have been no successful transplants and repatriations of this species. The only recovery activity taken to date is the construction of barriers to nonnative fish invasion in Aravaipa Creek. Several conservation actions have been taken to remove or prevent increased threats to loach minnow, most notably exclusion of livestock grazing from some occupied streams and their riparian corridors. We recommend several replication sites and implementing the existing recovery plan.

**Xyrauchen texanus Razorback sucker**  
Wild populations of the endangered razorback sucker are gone from the Basin where it once was widespread and abundant. No populations have been reestablished, notwithstanding an extensive repatriation program that has spanned more
than 20 years and stocked millions of fish. We advocate the development and implementation of innovative recovery strategies, such as those recommended for razorback sucker in the lower Colorado River.
Table 1. Historical distributions, known extirpated populations, and known naturally occupied streams for federal or state listed fishes of the Gila River basin, excluding *trouts*. (E=endangered, T=threatened, S=state listed, Ex=Extinct, PE=proposed endangered. Parentheticals denote major tributary affiliations, question marks denote uncertain status.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Historical distribution</th>
<th>Known extirpated populations</th>
<th>Known naturally occupied streams (exclusive of restoration sites; see Table 2)</th>
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<tbody>
<tr>
<td>Cyprinodon arcuatus (Ex)</td>
<td>-Low elevation streams, springs, cienegas, backwaters, and margins of larger rivers in the Santa Cruz River</td>
<td>-Santa Cruz River&lt;br&gt;-Monkey Spring (Santa Cruz)&lt;br&gt;-Sonoita Creek (Santa Cruz)</td>
<td>-Species is extinct</td>
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<td>Santa Cruz (Monkey Spring) pupfish</td>
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<td>Cyprinodon macularius (E)</td>
<td>-Low elevation streams, springs, cienegas, backwaters, and margins of larger rivers in the Gila River basin, including all major tributaries except the Santa Cruz River</td>
<td>-Agua Fria River&lt;br&gt;-Gila River&lt;br&gt;-Hassayampa River&lt;br&gt;-Salt River&lt;br&gt;-San Pedro River&lt;br&gt;-Verde River</td>
<td>-Gila River basin populations extirpated</td>
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<td>Desert pupfish</td>
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<tr>
<td>Gila elegans (E)</td>
<td>-Low-intermediate elevation mainstem reaches of the Gila and Salt rivers</td>
<td>-Gila River&lt;br&gt;-Salt River</td>
<td>-Gila River basin populations extirpated</td>
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<td>Bonytail</td>
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<td>Gila intermedia (PE)</td>
<td>-Upper reaches of small-middle sized streams of the Gila River basin, including all major tributaries</td>
<td>-Agua Fria River (Gila)&lt;br&gt;-Queen/Arnett creeks (Gila)&lt;br&gt;-San Simon River (Gila)&lt;br&gt;-Cave Creek/Seven Springs (Salt)&lt;br&gt;-Fish Creek (Salt)&lt;br&gt;-San Pedro River&lt;br&gt;-Binghamton Pond (San Pedro)&lt;br&gt;-Turkey Creek (San Pedro)&lt;br&gt;-Santa Cruz River&lt;br&gt;-Monkey Spring (Santa Cruz)&lt;br&gt;-Big Chino Wash (Verde)</td>
<td>-Indian Creek (Agua Fria)&lt;br&gt;-Little Sycamore Creek (Agua Fria)&lt;br&gt;-Silver Creek (Agua Fria)&lt;br&gt;-Sycamore Creek (Agua Fria)&lt;br&gt;-Bonita Creek (Gila)&lt;br&gt;-Eagle/East Eagle Creek (Gila)&lt;br&gt;-Mineral Creek/Devil's Canyon (Gila)&lt;br&gt;-Turkey Creek, NM (Gila)&lt;br&gt;-San Carlos River&lt;br&gt;-Blue River (San Carlos)&lt;br&gt;-Dix Creek (San Francisco)&lt;br&gt;-Harden Cienega (San Francisco)&lt;br&gt;-San Pedro River, Mexico&lt;br&gt;-Babocomari River (San Pedro)&lt;br&gt;-Hot Springs/Bass Canyon (San Pedro)&lt;br&gt;-Los Fresnos River, Mexico (San Pedro)&lt;br&gt;-O’Donnell Creek (San Pedro)&lt;br&gt;-Post/Freeman canyons (San Pedro)&lt;br&gt;-Redfield Canyon (San Pedro)&lt;br&gt;-Cienega Creek (Santa Cruz)&lt;br&gt;-Empire Gulch (Santa Cruz)&lt;br&gt;-Mattie Canyon (Santa Cruz)&lt;br&gt;-Sabino Canyon (Santa Cruz)&lt;br&gt;-Sheehy Spring (Santa Cruz)&lt;br&gt;-Red Tank Draw (Verde)&lt;br&gt;-Spring Creek (Verde)&lt;br&gt;-Walker Creek (Verde)&lt;br&gt;-Williamson Valley Wash (Verde)</td>
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<td>Gila nigra (S)</td>
<td>-Middle to headwater reaches of middle-sized tributary streams in the Verde, Tonto, San Carlos, and upper Gila River (NM) tributaries</td>
<td>-Beaver Creek (EF Gila River)&lt;br&gt;-Taylor Creek (EF Gila River)&lt;br&gt;-Christopher Creek (Tonto)&lt;br&gt;-Horton Creek (Tonto)&lt;br&gt;-Sharp Creek (Tonto)&lt;br&gt;-Rye Creek (Tonto)&lt;br&gt;-Dry Beaver Creek (Wet Beaver)</td>
<td>-Gila River, upper&lt;br&gt;-San Carlos River&lt;br&gt;-Ash Creek (San Carlos)&lt;br&gt;-Tonto Creek&lt;br&gt;-Buzzard Roost (Tonto)&lt;br&gt;-Gordon Creek (Tonto)&lt;br&gt;-Gunn Creek (Tonto)&lt;br&gt;-Haigler Creek (Tonto)&lt;br&gt;-Marsh Creek (Tonto)&lt;br&gt;-Rock Creek (Tonto)&lt;br&gt;-Spring Creek (Tonto)&lt;br&gt;-Deadman Creek (Verde)&lt;br&gt;-East Verde River (Verde)&lt;br&gt;-Fossil Creek (Verde)</td>
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<td>Headwater chub</td>
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<td>Species</td>
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<td>Known naturally occupied streams (exclusive of restoration sites; see Table 2)</td>
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| **Gila robusta (S)**  
Roundtail chub | -Middle-sized to larger streams of the Gila River basin, including all major tributaries except the Santa Cruz River | -Boneyard Creek (EF Black)  
-Gila River, middle reach (AZ)  
-Salt River, upper reach  
-San Francisco River (Gila)  
-Blue River (San Francisco)  
-San Pedro River  
-NF White River (White) ? | -Gila River, upper  
-Eagle Creek (Gila)  
-Salt River, lower reach  
-Salt River Project canals  
-Black River (Salt)  
-Canyon Creek (Salt)  
-Carrizo Creek (Salt)  
-Cedar Creek (Salt)  
-Cherry Creek (Salt)  
-Cibecue Creek (Salt)  
-Corduroy Creek (Salt)  
-Salome Creek (Salt)  
-White River (Salt) ?  
-Aravaipa Creek and tributaries (San Pedro)  
-Verde River  
-Fossil Creek (Verde)  
-Oak Creek (Verde)  
-West Clear Creek (Verde)  
-Wet Beaver Creek (Verde) |
| **Meda fulgida (T)**  
Spikedace | -Low-intermediate elevation streams in the Gila River basin, including all major tributaries except the Santa Cruz River | -Agua Fria River  
-Salt River  
-San Francisco River  
-San Pedro River, US and Mexico | -Eagle Creek (Gila)  
-Gila River, Middle Fork  
-Gila River, West Fork  
-Gila River, East Fork  
-Gila River, middle reach (AZ)  
-Mangus Creek (Gila)  
-Aravaipa Creek (San Pedro)  
-Verde River |
| **Plagopterus argentissimus (E)**  
Woundfin | -Low elevation streams in the Gila River basin, including all major tributaries except the Santa Cruz River | -Gila River  
-Salt River  
-Verde River | -Gila River basin populations extirpated |
| **Poeciliopsis occidentalis (E)**  
Gila topminnow | -Low-intermediate elevation streams, springs, ciénegas, backwaters, and margins of larger rivers in the Gila River basin, including all major tributaries | -Gila River  
-Ash Creek, North Fork (Gila)  
-Salt Creek (Gila)  
-San Simont River (Gila)  
-San Carlos River (Gila)  
-Salt River  
-Tonto Creek (Salt)  
-Frisco Hot Spring (San Francisco)  
-San Pedro River  
-Arivaca Creek (San Pedro)  
-Cocio Wash (Santa Cruz)  
-Potrero Creek (Santa Cruz)  
-Sabino Canyon (Santa Cruz)  
-Sheehy Spring (Santa Cruz)  
-Tanque Verde Creek (Santa Cruz)  
-Verde River  
-Other unnamed waters | -Bylas Springs (Gila)  
-Santa Cruz River, upper reach (US and Mexico)  
-Ciénegas Creek (Santa Cruz)  
-Cottonwood Spring (Santa Cruz)  
-Monkey Spring (Santa Cruz)  
-Sharp Spring (Santa Cruz)  
-Sonita Creek complex (Santa Cruz)  
-Redrock Canyon  
-Fresco Canyon  
-Coal Mine Canyon  
-Sonita Creek |
| **Ptychocheilus lucius (E)**  
Colorado squawfish | -Low-intermediate elevation streams in the Gila River basin, including all major tributaries except the Santa Cruz River | -Gila River  
-Salt River  
-San Pedro River  
-Verde River | -Gila River basin populations extirpated |
| **Tiaroga cobitis (T)**  
Loach minnow | -Low-high elevation streams in the Gila River basin, including all major tributaries except the Santa Cruz | -Gila River (AZ portion)  
-Salt River  
-San Pedro River, US and Mexico  
-Verde River | -Aravaipa Creek and tributaries (San Pedro)  
-Black River, North Fork of East Fork (Salt)  
-Blue River, and tributaries (San |
### Species

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<tr>
<th>Species</th>
<th>Historical distribution</th>
<th>Known extirpated populations</th>
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</table>
| Xyrauchen texanus (E) Razorback sucker | -Low-intermediate elevation streams in the Gila River basin, including all major tributaries except the Santa Cruz River | -Gila River  
- Salt River  
- San Pedro River  
- Verde River |

- Gila River basin populations extirpated
Table 2. Status of transplant and repatriation activities for federal or state listed fishes of the Gila River basin (excluding trouts) 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. (Abbreviations as follow: BTA = Pond on Queen Creek, Boyce Thompson Arboretum, Gila Co., AZ; CADFG = California Department of Fish and Game, NFH = USFWS National Fish Hatchery; NWR = USFWS National Wildlife Refuge, SFH = State Fish Hatchery, TNC = The Nature Conservancy. All locations are in Arizona unless specified otherwise.)

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<tr>
<th>Species</th>
<th>Successful population establishment</th>
<th>Unsuccessful population establishment</th>
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<tr>
<td><em>Cyprinodon arcuatus</em> (Santa Cruz pupfish)</td>
<td>-Conservation-based transplants to ASU Department of Zoology, Maricopa Co., AZGFD ponds in Deer Valley, Maricopa Co., and AZGFD Page Springs SFH, Yavapai Co., in 1969-1971, where the species persisted for a time after extirpation in the wild. The species became extinct when these refugium stocks perished in 1971 by failing to reproduce. No other transplant records are known.</td>
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| *Cyprinodon macularius* (Desert pupfish) | -To Cold Springs Seep, Graham Co., from Flowing Wells Jr. HS, Tucson via BTA, and Dexter NFH (Mexico, Sonora, Santa Clara Slough stock), 1990, presumed extant  
- To Lousy Canyon, Yavapai Co., from El Doctor, Sonora, Mexico via Cibola and Imperial NWRs, 2001, presumed extant.  
- Numerous stockings or reintroductions into more than a dozen wild locations (Minckley and Brooks 1985, Marsh and Sada 1993, Weedman and Young 1997) |                                                                                                         |
| *Gila elegans*                  | -No documentation of any transplant to a wild site within the Gila River basin.                     |                                                                                                         |
| *Gila intermedia* (Gila chub)  | -To Larry Creek, Yavapai Co., from Silver Creek, Yavapai Co., 1995, status unknown  
- To Lousy Canyon, Yavapai Co., from Silver Creek, Yavapai Co., 1995, status unknown  
- To O'Donnell Creek, Santa Cruz Co., from same-site stock salvaged before stream renovation, 2002, extant.  
- To BTA from Salt River at Tempe, Maricopa Co., 1930s, extirpated  
- To Garden Canyon, Cochise Co., from Turkey Creek, Cochise Co., 1988, extirpated (Weedman et al. 1996) |                                                                                                         |
| *Gila nigra*                   | -No documentation of any transplant to a wild site within the Gila River basin.                     |                                                                                                         |
| *Gila robusta*                 | -No documentation of any transplant to a wild site within the Gila River basin.                     |                                                                                                         |
| *Meda fulgida* (Spikedace)     | -To Sonolita Creek, Santa Cruz Co., from Aravaipa Creek, Graham Co., 1968, extirpated  
- To Seven Springs Wash, Maricopa Co., from Aravaipa Creek, Pinal Co., 1970, extirpated |                                                                                                         |
| *Plagopterus argentissimus* (Woundfin) | -To Hassayampa River, Maricopa Co., from Virgin River, Coconino Co., 1972, extirpated  
- To Salt River, Maricopa Co., from Virgin River, Coconino Co., 1972, extirpated  
- To Sycamore Creek, Yavapai Co., from Virgin River, Coconino Co., 1972, extirpated  
- To Verde River Yavapai Co., from Virgin River, Coconino Co., date and status unknown |                                                                                                         |
| *Poeciliopsis occidentalis* (Gila topminnow) | -To AD Wash, Yavapai Co., from Dexter NFH (Sharp Spring stock), 1993, presumed extant  
- To Charlebois Spring, Pinal Co., from BTA, 1983, presumed extant  
- To Cold Springs, Graham Co., from Dexter NFH (Monkey Spring stock), 1985, presumed extant  
- To Dutchman Grave Spring, Yavapai | -More than 200 reintroductions or natural dispersals from stocking at 175 wild locations, 17 of which remained in 1998, including one outside of historical range (Weedman 1998, U.S.Fish and Wildlife Service 1999).  
- To NMDFG Red Rock Wildlife Management Area, Hidalgo Co., New Mexico, from Dexter NFH (Sharp Spring stock), 1989, likely extirpated |
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<tr>
<th>Species</th>
<th>Successful population establishment</th>
<th>Unsuccessful population establishment</th>
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<td>2. -To Heron Spring, Santa Cruz Co., from Sharp Spring, 1981 and 1987, extant</td>
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<td>3. -To Hidden Water Spring, Maricopa Co., from Monkey Spring, 1976, and from BTA, 1981, extant</td>
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<td>4. -To Johnson Wash Spring, Yavapai Co., from BTA, 1982, presumed extant</td>
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<td>5. -To Kayler Spring, Gila Co., from BTA, 1982, presumed extant</td>
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<td>6. -To Lime Creek, Yavapai from BTA via Lime Cabin Spring, before 1996, presumed extant</td>
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<td>7. -To Lower Mine Spring, Yavapai Co., from BTA, 1983, presumed extant</td>
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<td>8. -To Mescal Warm Spring, Gila Co., from Dexter NFH (Monkey Spring stock), 1985, presumed extant</td>
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<td>9. -To Mud Spring, Maricopa Co., from BTA, 1982 and 1997, extant</td>
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<td>10. -To Tule Creek, Yavapai Co., from BTA, 1981, presumed extant</td>
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<td>11. -To unnamed drainage #68, Maricopa Co., from BTA via Mesquite Tank #2, 1982-1985, presumed extant</td>
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<td>12. -To Walnut Spring, Maricopa Co., from BTA, 1982, extant</td>
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<td>13. -To Watson Wash, Graham Co., from unknown source, unknown date 1984-1989, presumed extant</td>
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<td>14. -To Yerba Mansa (Grapevine Spring), La Paz Co., from BTA via Tule Creek and Dexter NFH (Sharp Spring stock), 1984, 1985, and 1988, presumed extant</td>
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<td>15. -To Empire Gulch, Pima Co., from Cienega Creek, 2001, presumed extant</td>
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<tr>
<td>Tiaroga cobitis</td>
<td>1. -To multiple sites on Salt and Verde rivers, central AZ from Dexter NFH and/or AZGFD Bubbling Ponds SFH, 1981-1990. More than 750,000 individuals stocked (mostly larvae and fingerlings), 444 total recaptures, most within a few months of release. No evidence of long-term survival, reproduction, or recruitment (Creef et al. 1992, Hendrickson 1993, Young 1998, Jahrke and Clark 1999)</td>
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<td>2. -To Sonoita Creek, Santa Cruz Co., from Aravaipa Creek, Graham Co., 1968, extirpated</td>
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<tr>
<td>Species</td>
<td>Successful population establishment</td>
<td>Unsuccessful population establishment</td>
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</table>
Table 3. Recovery and conservation activities (post-1967) for federal or state listed fishes of the Gila River basin (excluding trouts). (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. More complete literature reviews can be found in recovery plans and other recent documents.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Recovery activities excluding transplants/repatriations</th>
<th>Conservation activities</th>
<th>Monitoring, surveys, captive populations, and research activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprinodon arcuatus Santa Cruz (Monkey Spring) pupfish</td>
<td></td>
<td>-Taxonomic recognition (Minckley et al. 2002)</td>
<td></td>
</tr>
<tr>
<td>Cyprinodon macularius Desert pupfish</td>
<td>-Closure of Bog Hole to sport fishing</td>
<td>-Regular monitoring of occupied sites (Weedman and Young 1997)</td>
<td>-Ecological studies (Lowe et al. 1967, Hendrickson and Varela-Romero 1989, Minckley et al. 1991, Campoy-Favela 1996, Johnson 2002) -Genetics studies (Echelle et al. 2000) -Multiple transfers to hatcheries, laboratory facilities, refugium sites, public and private aquaria and other locations within and outside Arizona; not updated since the recovery plan was published in 1993</td>
</tr>
<tr>
<td>Gila nigra Headwater chub</td>
<td>-Decommissioning of Childs/Irving hydropower facility (pending) -Crayfish trapping in Fossil Creek</td>
<td>-Taxonomic recognition (Minckley and DeMarais 2000) -Status review (Voeltz 2002) -Ongoing genetics studies</td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Recovery activities excluding transplants/repatriations</td>
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</tr>
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<tr>
<td><em>Gila robusta</em></td>
<td>- Aravaipa barriers</td>
<td>- Designation as sport fish in AZ</td>
<td>- Annual monitoring in Gila R. in NM (Propst 2002), upper Verde R. (Rinne et al. 1998), Aravaipa Creek (Velasco 1997)</td>
</tr>
<tr>
<td>Roundtail chub</td>
<td>- Stock Salt River (pending)</td>
<td>- Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</td>
<td>- Propagation studies of Verde R population</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Decommission of Childs/Irving hydropower facility (pending)</td>
<td>- Status review (Voeltz 2002, Bezzerides and Bestgen 2002)</td>
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<tr>
<td></td>
<td></td>
<td>- Nonnative threat control (restrictions on live bait fish use and increased nonnative fish bag limits in AZ)</td>
<td>- Genetics studies (DeMarais 1992, Gerber et al. 2001), and ongoing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Crayfish trapping in Fossil Creek</td>
<td>- Annual monitoring in Gila R. in NM (Propst 2002), upper Verde R. (Rinne et al. 1998), Aravaipa Creek (Velasco 1997)</td>
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<tr>
<td></td>
<td></td>
<td>- Land acquisition of Morgan Ranch (Verde River)</td>
<td>- Propagation studies at UNM</td>
</tr>
<tr>
<td><em>Meda fulgida</em></td>
<td>- Aravaipa barriers</td>
<td>- Water developments cancelled or altered (upper Gila River Connor/Hooker Dam, Upper Verde CAP water diversion)</td>
<td>- Multiple transfers to hatcheries or laboratory facilities (e.g., ASU Department of Biology, University of Arizona Environmental Research Laboratory, University of New Mexico Museum of Southwestern Biology).</td>
</tr>
<tr>
<td>Spikedace</td>
<td></td>
<td>- Road and bridge activities cancelled or altered (East Fork Gila River road development, Romero Road bridge relocation on San Pedro, Aravaipa bridge)</td>
<td>- Genetics studies (Tibbets 1993)</td>
</tr>
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<td></td>
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<td>- 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)</td>
<td>- Distribution and life history studies (Propst et al. 1985, Propst et al. 1986)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nonnative threat control (restrictions on live bait fish use and increased nonnative fish bag limits in AZ)</td>
<td>- Ecological studies (Propst et al. 1986, Marsh et al. 1989, Rinne 1992, Douglas et al. 1994)</td>
</tr>
<tr>
<td>Species</td>
<td>Recovery activities excluding transplants/repatriations</td>
<td>Conservation activities</td>
<td>Monitoring, surveys, captive populations, and research activities</td>
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<tr>
<td>Plagopterus argentissimus</td>
<td><strong>Woundfin</strong> - Bylas Springs renovations (4?), barriers (3), and habitat restoration - Cottonwood Artesian and Mud Spring habitat construction (new ponds) - Tule Creek barrier - Arnett Creek barrier and renovation - Cienega Creek habitat reconstruction and dam removal - Upper Sonoita Creek railroad abutment removal</td>
<td>- Land acquisition: Sonoita Creek, Fresno Canyon, Coalmine Canyon (State and The Nature Conservancy) Cienega Creek (BLM) Sharp Spring (State) - Redrock Canyon – road closures - Cienega Creek basin closed to angling - Hidden Water Spring fenced from livestock grazing, although presence of wild burro population reduces effectiveness - Redrock Canyon (Gate Spring) deflectors - Cottonwood Spring erosion control structures - Miscellaneous livestock exclosures (Cottonwood Spring, Cottonwood Artesian, Johnson Wash, Hidden Water Spring, Redrock Canyon, Bylas Springs, Cienega Creek, Sharp Spring, Tule Creek, Kayler Spring, and others) - Mud Spring pond excavations</td>
<td>- Multiple transfers to hatcheries or laboratory facilities (e.g., UNLV Department of Biology, Dexter NFH) - Regular monitoring of occupied sites (Weedman and Young 1997) - Genetics studies (Hedrick and Parker 1998, Parker et al. 1998, Parker et al. 1999, Hedrick and Parker 1999, Sheffer et al. 1999, Hedrick 2000, Hedrick et al. 2001a, Hedrick et al. 2001b) - Ecological studies (Schoenherr 1974, 1977, Schoenherr 1981, Constantz 1981, Meffe 1984a, Meffe 1984b, Simms and Simms 1992, Forrest 1992, Leberg and Vrijenhoek 1994, Stefferud and Stefferud 1995, Minckley 1999, Johnson 2002, Schultz et al. 2003) - Multiple transfers to hatcheries, laboratory facilities, refugium sites, public and private aquaria and other locations within and outside Arizona; not updated since the most recent (1999) draft recovery plan was last circulated for comments</td>
</tr>
<tr>
<td>Ptychocheilus lucius</td>
<td><strong>Colorado squawfish</strong> - Stock Salt River (pending)</td>
<td>- Change in angling regulations in Arizona - Salt River diversion dam modification into barrier - Nonnative threat control (restrictions on live bait fish use and increased nonnative fish bag limits in AZ)</td>
<td>- Multiple transfers to hatcheries or laboratory facilities (e.g., Dexter NFH, Hotchkiss NFH, Willow Beach NFH, AZGFD Bubbling Ponds SFH, CADFG Chino SFH, Arizona-Sonora Desert Museum) - Ecological studies (Clarkson et al. 1993, Childs and Clarkson 1996, Robinson et al. 1997, Robinson et al. 1998)</td>
</tr>
<tr>
<td>Tiaroga cobitis</td>
<td><strong>Loach minnow</strong> - Aravaipa barriers</td>
<td>- Water development cancelled or altered (Connor/Hooker Dam, Pigeon Creek Reservoir, White River water diversion) - Road/bridge activities cancelled or altered (East Fork Gila River road development, Blue River road maintenance, ORV road closures on San Francisco and Blue)</td>
<td>- Annual monitoring in Gila and San Francisco rivers in NM (Rinne et al. 1998), Aravaipa Creek (Velasco 1997) - Propagation studies at Alchesay (David and Wirtanen 2001) - Multiple transfers to hatcheries or laboratory facilities (e.g., Alchesay NFH, AZGFD Bubbling Ponds SFH, ASU Department of Biology)</td>
</tr>
<tr>
<td>Species</td>
<td>Recovery activities excluding transplants/repatriations</td>
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<tr>
<td>Razorback sucker</td>
<td>-Livestock grazing improvements (exclusion of river on portions of Gila in NM, Blue and San Francisco in AZ, Aravaipa Creek BLM lands, parts of Eagle Creek) -Nonnative threat control (restrictions on live bait fish use and increased nonnative fish bag limits in AZ)</td>
<td>-Livestock grazing improvements (exclosure of upper Verde and portions of middle Verde) -Nonnative threat control (restrictions on live bait fish use and increased nonnative fish bag limits in AZ)</td>
<td>Georgia Southern University Department of Biology, University of Arizona Environmental Research Laboratory) -Ecological studies (Propst and Bestgen 1991, Rinne 1992, Velasco 1997, Bagley 2002, Propst 2002) -Genetic studies (Tibbets 1993, Tibbets and Dowling 1996)</td>
</tr>
</tbody>
</table>
Table 4. Recommendations for transplants and replications, and conservation and recovery actions, for federal or state listed fishes of the Gila River basin, excluding trouts.

<table>
<thead>
<tr>
<th>Species</th>
<th>Recommended replication sites (not an exhaustive listing)</th>
<th>Recommendations for actions</th>
</tr>
</thead>
</table>
| Cyprinodon arcuatus  
Santa Cruz (Monkey Spring) pupfish | -Not applicable | -Implement recovery plan (Marsh and Sada 1993)  
-Evaluate use of *C. macularius* in former habitat of *C. arcuatus* |
| Cyprinodon macularius  
Desert pupfish | -Arnett Creek (Gila)  
-TNC San Pedro Preserve Pond (San Pedro)  
-Bingham Cienega (San Pedro)  
-Cienega Creek  
-Lewis Spring (San Pedro)  
-O’Donnell Canyon (San Pedro)  
-Turkey Creek (San Pedro)  
-Post Canyon (San Pedro)  
-Hidden Water Spring (Salt)  
-Suitable habitats in the Santa Cruz basin (Boghole, Sheehy Spring, Sonoita Creek, Sharp Spring, Cottonwood Spring, Agua Caliente)  
-Stock BLM pits along Gila River | -Implement recovery plan (Marsh and Sada 1993)  
-Evaluate use of *C. macularius* in former habitat of *C. arcuatus* |
| Gila elegans  
Bonytail | -Gila River, upper reach (AZ) | -Implement recovery plan (U.S.Fish and Wildlife Service 1990) |
| Gila intermedia  
Gila chub | -Morgan City Wash (Agua Fria)  
-Cave Creek/Seven Springs (Salt)  
-San Simon Cienega  
-Martinez Creek (Gila)  
-San Pedro River  
-Turkey Creek, Post Canyon (Babocomari)  
-TNC San Pedro Preserve pond  
-Redrock Canyon (Santa Cruz)  
-Sharp Spring, Bog Hole (Santa Cruz)  
-Replicate Sabino pop in other appropriate sites, e.g., Coalmine Spring/Fresno Canyon, Scotia Canyon, Peck Canyon, Temporal Gulch, Tanque Verde Canyon  
-Replicate appropriate stock (Agua Fria?) into Cave Cr/7 Springs  
-Replicate Sheehy Spring stock into Sharp Spring and Boghole  
-Restock Turkey Creek | -Federal listing w/critical habitat  
-Remove nonnative fishes from occupied habitats  
-Land acquisition at Coalmine Spring  
-Genetic studies of intra-population variation  
-Systematic monitoring and comprehensive reporting |
| Gila nigra  
Headwater chub | -Greenback Creek (Tonto)  
-Evaluate stocking in Horton Creek | -Federal listing w/critical habitat  
-Construct barrier in Fossil Creek  
-Renovate Fossil Creek  
-Remove nonnative fishes from occupied habitats  
-Systematic monitoring and comprehensive reporting |
| Gila robusta  
Roundtail chub | -Blue River (San Francisco)  
-Salt River above Roosevelt Lake  
-WF Black (Black) | -Federal listing w/critical habitat  
-Construct barrier in Fossil Creek  
-Renovate Fossil Creek  
-Remove nonnative fishes from occupied habitats  
-Systematic monitoring and comprehensive reporting |
| *Meda fulgida*  
Spikedace | -Bonita Creek (Gila)  
-Blue River (San Francisco)  
-Hot Springs Canyon (San Pedro)  
-Redfield Canyon (San Pedro)  
-San Pedro River  
-Fossil Creek (Verde)  
-Tonto Creek (Salt)  
-Reintroduce in Fossil Creek upon completion of renovation | -Implement recovery plan (U.S.Fish and Wildlife Service 1991c)  
-Survey Eagle Creek  
-Survey upper Verde River  
-Construct barrier in Fossil Creek  
-Renovate Fossil Creek  
-Remove nonnative fishes from occupied habitats  
-Systematic monitoring and comprehensive reporting |
<table>
<thead>
<tr>
<th>Species</th>
<th>Recommended replication sites (not an exhaustive listing)</th>
<th>Recommendations for actions</th>
</tr>
</thead>
</table>
| Plagopterus argentissimus Woundfin | -Gila River, upper reach (AZ)  
- Hassayampa River  
- Tonto Creek  
- Implement recovery plan (U.S. Fish and Wildlife Service 1984a)  
- Revoke experimental-nonessential stocking rule (U.S. Fish and Wildlife Service 1985)  
- Evaluate Gila Box RNCA for stocking |  
- Reinstate aggressive stocking program into waters on public lands  
- Implement management recommendations (Minckley 1999)  
- Implement recovery plans (U.S. Fish and Wildlife Service 1984b)  
- Finalize draft recovery plan (Weedman 1998)  
- Systematic monitoring and comprehensive reporting  
- Coalmine Canyon land acquisition and fencing  
- Improve habitat at Walnut Spring |  
| Poeciliopsis occidentalis Gila topminnow | - Aravaipa Creek tributaries  
- Arnett Creek  
- Additional waters identified in the draft Gila Topminnow Revised Recovery Plan  
- Reinstate aggressive stocking program into waters on public lands  
- Implement management recommendations (Minckley 1999)  
- Implement recovery plans (U.S. Fish and Wildlife Service 1984b)  
- Finalize draft recovery plan (Weedman 1998)  
- Systematic monitoring and comprehensive reporting  
- Coalmine Canyon land acquisition and fencing  
- Improve habitat at Walnut Spring |  
| Ptychocheilus lucius Colorado squawfish | - Gila River  
- Salt River  
- Verde River  
- Implement recovery plan (U.S. Fish and Wildlife Service 1991a), and other innovative strategies (e.g., Minckley et al. 2003)  
- Revoke experimental-nonessential stocking rule (U.S. Fish and Wildlife Service 1985) |  
| Tiaroga cobitis Loach minnow | - Hot Springs, Redfield canyons (San Pedro)  
- San Pedro River  
- Open Draw (Black)  
- Tonto Creek (Salt)  
- Fossil Creek (Verde)  
- Bonita Creek (Gila)  
- Fossil Creek upon completion of renovation  
- Implement recovery plan (U.S. Fish and Wildlife Service 1991b)  
- Construct barrier in Fossil Creek  
- Renovate Fossil Creek  
- Remove nonnative fishes from occupied habitats  
- Systematic monitoring and comprehensive reporting |  
| Xyrauchen texanus Razorback sucker | - Gila River  
- Bonita Creek (Gila)  
- Eagle Creek (Gila)  
- Blue River (San Francisco)  
- Salt River  
- Verde River  
- Fossil Creek (Verde) once stream is renovated  
- Replicate populations into other suitable streams  
- Implement recovery plan (U.S. Fish and Wildlife Service 1998), and other innovative strategies (e.g., Minckley et al. 2003)  
- Systematic monitoring and comprehensive reporting  
- Evaluate suitability of Bonita Creek for stocking |
Literature cited


