ANALYSIS OF RECOVERY PLAN IMPLEMENTATION FOR THREATENED AND ENDANGERED WARM WATER FISHES OF THE GILA RIVER BASIN

Desert Fishes Team
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Disclaimer

The conclusions and recommendations in this report are the culmination of deliberations of the Desert Fishes Team (DFT), an independent group of scientists, 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. The DFT includes personnel from state and federal agencies, academia, non-governmental organizations, and the private sector. The content or opinion expressed in this report does not necessarily represent views, policies, or official positions of any other entity, including agencies, institutions, or organizations that may employ DFT participants.

Other reports by the Desert Fishes Team

This is the third in a series of reports on Gila River basin fishes that the Desert Fishes Team has produced. The first two reports dealt with the status of federal and state listed warm water fishes (Report 1), and the status of unlisted warm water fishes (Report 2).

Status of federal and state listed warm water fishes of the Gila River basin, with recommendations for management. Desert Fishes Team Report 1, October 2003. Desert Fishes Team, Phoenix, Arizona. 22 pp.

Status of unlisted native fishes of the Gila River basin, with recommendations for management. Desert Fishes Team Report 2, August 2004. Desert Fishes Team, Phoenix, Arizona. 27 pp.

Reports in .pdf format are available at www.nativefishlab.net. Printed copies may be requested by writing to: Desert Fishes Team, P.O. Box 16815, Phoenix, AZ 85011-6815, or by sending a request to Stefferud@cox.net.

Literature citation for this report should read as follows:

Desert Fishes Team. 2006. Analysis of recovery plan implementation for threatened and endangered warm water fishes of the Gila River basin. Desert Fishes Team Report 3. Desert Fishes Team, Phoenix, Arizona.

Executive Summary

Purpose: Earlier reports by the Desert Fishes Team provided information on the status of the 19 native Gila River basin warm water fishes, with recommendations for management. Nine of these species are federally-listed, and eight have approved recovery plans, which have been in existence between 9 and 28 years. Most recovery plans have been either revised, amended, supplemented, or re-drafted since their initial approval, and thus represent up-to-date ecological, biological, and cultural conditions and scientific approaches to management and recovery of the species. This report documents extent of implementation of existing recovery plans for the federally-listed warm water fishes in the Gila River basin.

Organization: A summary for each species is given in the text. Each summary report is accompanied by a Table that includes the recovery task and a numerical score denoting the Team's assessment of how well the task has been implemented, current status of the species in the Gila River basin, and a comparison of the five listing factors (from the Endangered Species Act) at the time of listing with the current situation (as of 2006). The appendix includes recovery goals and related information from the recovery plans, including lists of tasks, subtasks, and their priorities identified in the recovery plans, accomplishments, implementation status (a numerical score), and Team-assigned scores of how well each particular subtask has been implemented in the Gila River basin.

Conclusions: Recovery plan tasks remain pertinent although many could be updated to reflect new information, recovery philosophies, and policy. Implementation and accomplishment of recovery plan tasks for warm water fishes in the Gila River basin has been inadequate. Nearly all of the listed warm water species have experienced declines in range and abundance since they were listed. Their status continues to decline, and in many cases the decline is accelerating. The prognosis for recovery of any Gila River basin warm water fish in the foreseeable future is bleak, unless management direction changes in a positive manner, and recovery plan tasks and subtasks are implemented in an effective and timely manner. Technical tools needed to implement and attain recovery are in hand, but severely limited resources, burgeoning non-biological constraints, and lack of positive leadership for recovery of native fishes have dictated inaction for most species.

Recommendations: We recommend that the leadership of agencies concerned with native fish management recommit to an aggressive program for the on-the-ground betterment of native warm water fishes in the Gila River basin. Recent successful projects (e.g., renovations followed by repatriations of native fishes, land acquisitions, barrier construction, and others), although few in number, have shown that recovery tasks can be undertaken and that they are supported by the public. These successes need to be built upon and emphasized, because they can represent the future for native fish in the Gila River basin.

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ANALYSIS OF RECOVERY PLAN IMPLEMENTATION FOR THREATENED AND ENDANGERED WARM WATER FISHES OF THE GILA RIVER BASIN

Introduction

The fish assemblage native to the Gila River basin in Arizona, New Mexico, and Sonora is critically imperiled, with a majority of the species listed as endangered or threatened under federal law, or rare or of special concern under state wildlife laws. The federal Endangered Species Act (ESA) was enacted in 1973 to provide a means to conserve ecosystems and to provide a program for the conservation of listed species. Listing of an animal under ESA obligates the preparation and implementation of a recovery plan for the conservation and survival of the individual listed species. The purpose of a recovery plan is to: 1) incorporate a description of site-specific management actions needed for conservation and survival of the species, 2) provide objective, measurable criteria that when met would result in the species being removed from the list, and 3) give estimates of time and cost required to achieve the plan's goals. The plans also identify who the responsible parties are to implement the on-the-ground recovery actions. However, the plans are not binding on any of the parties, nor are they regulatory documents.

Historically, recovery plans were usually drafted by recovery teams chartered by the U.S. Fish and Wildlife Service (USFWS). These teams were comprised of scientists, biologists, and individuals from federal and state agencies, academia, non-governmental organizations, and the private sector who were knowledgeable of the species of interest. Currently, newly formed teams now are often comprised of "stakeholders" who may or may not have expertise on the biology or ecology of the species, but who are included for primarily political considerations. After review and revision, recovery plans are approved by the USFWS. Existing recovery plans can be revised, amended, supplemented, or completely re-drafted as needed to reflect new information regarding biology of the species, new threats that may impact its recovery, or changes in recovery philosophy or policy.

Current guidelines for recovery plans require that they have site-specific management actions, objectives, measurable criteria, and estimates of the time and costs to carry out those measures needed to achieve the plan's goals, and to achieve intermediate steps toward that goal. Quantifiable recovery criteria must be developed, and the linkage with biological requirements of the species must be clearly defined. Monitoring is to be done not only on the status of the species, but also on progress toward implementation of recovery goals. All recovery plans are to be reviewed on a regular basis.

Nine of the nineteen native warm water fishes in the Gila River basin[1] are listed under ESA as

[1] The Gila River basin has 21 native fish species. In addition to the nine species considered here, two are State listed, one is extinct, seven have no listing status, and two are trouts. Both trouts are Federal and State listed, but because they are cold water sport species and have distinctly separate and more active recovery and conservation programs, we chose not to include them in this status report.

threatened or endangered. Recovery plans for desert pupfish *Cyprinodon macularius*, bonytail *Gila elegans*, spikedace *Meda fulgida*, woundfin *Plagopterus argentissimus*, Gila topminnow *Poeciliopsis occidentalis*, Colorado pikeminnow *Ptychocheilus lucius*, loach minnow *Tiaroga cobitis*, and razorback sucker *Xyrauchen texanus* have been in existence for between 9 and 28 years (Table 1). Gila chub *Gila intermedia* was listed in 2005, and as yet has no recovery plan. Four of the eight recovery plans have been revised, amended, or supplemented, and one has been re-drafted. All recovery plans describe a program of work (tasks or factors, with subtasks) for protection, enhancement, and monitoring of extant populations, reestablishment of populations, studies and research, and public information. In sum, if they were implemented as planned, these tasks would provide for recovery of each species in a practical period of time with a reasonable level of multi-agency funding. Recovery plans for desert pupfish and woundfin recognize that full recovery (Federal protection no longer needed) may not be feasible due to irrevocable losses and insoluble threats, but provide for substantial species stabilization and improvement through task implementation.

In this report, we examine how well the suite of recovery actions described for each of the listed warm water fishes in the Gila River basin has been implemented and accomplished within the basin. Four of the species we address are endemic to the Gila River basin, the others ranged more widely in the Colorado River basin. Seven recovery plans delineate actions in the Gila River basin that are necessary to achieve recovery, either downlisting or delisting. The recovery plan for one species has determined that recovery criteria for the lower Colorado River basin will be evaluated at a future date. We assess only those recovery actions that are pertinent to the Gila River basin.

Table 1. Year and category of listing under ESA, and date of approval of recovery plan including revisions and supplements for Federally listed warm water fishes in the Gila River basin.

Species	ESA Listing	Category	Recovery plan date of approval
Desert pupfish	1986	Endangered w/critical habitat	1993
Bonytail	1980	Endangered w/critical habitat	1984, 1990, 2002 (supplement)
Gila chub	2005	Endangered w/critical habitat	None
Spikedace	1986	Threatened	1991
Woundfin	1970	Endangered	1979, 1985, 1995
Gila topminnow	1967	Endangered	1984, 1999 (draft revision)
Colorado pikeminnow	1967	Endangered w/critical habitat	1978, 1991, 2002 (supplement)
Loach minnow	1986	Threatened	1991
Razorback sucker	1990	Endangered w/critical habitat	1998, 2002 (supplement)

Methods

First, we collectively reviewed tasks and subtasks in the eight recovery plans and supplements available. This review consisted of assessing whether: 1) the subtask was pertinent to the Gila River basin, 2) the subtask had been initiated, and 3) the subtask had been completed. To facilitate this review, tasks and subtasks from each recovery plan were copied into a separate document, which also included recovery goals and related information from each recovery plan. Tasks and subtasks that addressed actions in watersheds outside of the Gila River basin were deemed not applicable (N/A). We considered only actions that had been done since approval of the recovery plan. While we recognized that actions pertinent to recovery plan goals may have occurred prior to recovery plan approval, the purpose of this report was to assess implementation of recovery plans.

Following the initial review, a seven-member scientific review panel (a subset of the Desert Fishes Team [DFT]) evaluated the degree to which tasks and subtasks in recovery plans for Gila River basin fishes had been accomplished. The panel included scientists who were knowledgeable and/or had performed research on the species, biologists from agencies and non-governmental organizations who were responsible for management of the species and their habitats, and other personnel with extensive knowledge of Gila River basin fishes and their habitats. Panelists were requested to set aside their affiliations and, using their best scientific judgment, objectively evaluate how well the subtasks outlined in recovery plans had been accomplished to date.

The panel individually scored the level of implementation on a 5-tier (0 to 4) scale[2], a method used effectively by Williams et al. (2005) to evaluate recovery efforts for Borax Lake chub, an endangered fish in Oregon. Scores assigned individually to each subtask were averaged, and then those mean subtask scores were averaged to determine the mean task score. If there were scores for any subtask that were obviously anomalous, the panel collectively discussed them and resolved any inconsistencies.

Species accounts

The following species accounts provide a brief summary of the current status of each species, recovery plan objectives, goals, and recovery criteria, threats to the species, and notable successes and failures of recovery plans. An accompanying table includes the tasks from the recovery plan and average task accomplishment scores, and a review of the five listing factors that compares habitat conditions and threats to survival of the species at the time of listing (or earliest time when the listing factors were described) with current conditions. Current status is based on accounts provided in earlier reports by the Desert Fishes Team (DFT), and from USFWS (2004), a report to Congress that evaluated recovery of endangered and threatened species for the fiscal years 2001-2002.

Recovery goals, tasks, subtasks copied verbatim from recovery plans are available in the appendix to this report. The appendix also provides mean subtask scores assigned by the Desert Fishes Team.

Desert pupfish
Cyprinodon macularius

Desert pupfish was listed as endangered in 1986 and a recovery plan approved seven years later (USFWS 1986a, 1993). The recovery objective was downlisting to threatened status, which was projected to occur in 15 years from the time of recovery plan approval (i.e., 2008). There was no provision for delisting, which the recovery plan did not expect to be achievable. Primary recovery criteria included protection of natural populations and establishment of 55 additional populations in secure habitats within probable historical range. Recovery goals provided quantitative criteria, but did not clearly describe the relationship of the criteria to the biology of the species. The recovery plan is currently undergoing review.

Desert pupfish historically occupied low elevation streams, springs, cienegas, backwaters, and margins of larger rivers in the Gila River basin, including all major tributaries except the Santa

[2] Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Cruz River, which was occupied by the now-extinct Santa Cruz (Monkey Spring) pupfish *C. arcuatus*. Current distribution in the Gila River basin includes six translocated populations in the wild, and numerous captive populations; no wild populations are known to exist in the basin.

The recovery plan step-down outline identified seven tasks comprised of eleven subtasks that were needed to effect recovery (Appendix: desert pupfish). Tasks 1 and 3 were not applicable to the Gila River basin because they dealt specifically with California populations of desert pupfish or the Quitobaquito pupfish *Cyprinodon eremus*[3]. All other tasks applicable to the Gila River basin have been initiated (Table 2). Six of the seven subtasks (86%) have been initiated, none are completed. Although the proportion of subtasks initiated is high, the average score for accomplishment is very low because few activities among many identified opportunities have actually been performed.

For example, Task 2 calls for establishment in Arizona of 55 populations of desert pupfish in the wild within historical range, but only six stockings have occurred since the recovery plan was approved 13 years ago, and only one of these currently meets recovery plan criteria for persistence for at least 10 years. A genetic exchange protocol was developed to help direct recovery efforts (Task 4), but has not been used. Monitoring of populations in the Gila River basin (Task 5) does not meet recovery plan criteria. Life history information for desert pupfish is available for populations outside of the Gila River basin, but has not been applied to determine factors affecting population persistence in the basin. Information and education (Task 7) includes stocking of school ponds, and a brochure specific to Gila topminnow and desert pupfish was produced for public dissemination. There are other ongoing efforts for native fish in general, but not specifically for desert pupfish.

Threats to populations in the Gila River basin identified at time of listing are still present, and some such as water use, are increasing. New threats have arisen, such as the introduction and spread of aquatic fern (giant salvinia *Salvinia molesta*) in the lower Colorado River system that may make habitats unsuitable for desert pupfish. Inland silverside *Menidia beryllina*, recently discovered in Lake Pleasant, is a potential threat if it spreads to habitats occupied by desert pupfish. Asian tapeworm *Bothriocephalus acheilognathi* is spreading into other populations of native fishes.

Our analysis estimated that progress toward achievement of recovery goals was very low, which was consistent with the assessment of 0-25% achievement of recovery objectives for desert pupfish in USFWS's 2004 report to Congress on endangered and threatened species recovery. Progress toward recovery of desert pupfish has been virtually nonexistent until recently and the species cannot be down-listed by the 2008 target date set by the recovery plan. In fact, even if all 55 new populations prescribed by the recovery plan were established immediately and other criteria were met, desert pupfish could not be considered eligible for down listing for at least another decade.

Table 2. Summary of status review findings for the desert pupfish relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation

[3] Quitobaquito pupfish was considered a subspecies of desert pupfish until elevated to full species status in 2000. Quitobaquito pupfish is endemic to Quitobaquito Spring and pond in Organ Pipe Cactus National Monument, Arizona, and to the Sonoyta River, Sonora, both outside the Gila River basin. This change in taxonomical classification has not been reflected in Code of Federal Regulations lists of endangered species.

Tasks	Average subtask score
1. Protect natural populations of desert pupfish.	N/A
2. Re-establish desert pupfish populations.	1.0
3. Establish a refugium population of Quitobaquito pupfish.	N/A
4. Develop protocols for exchange of genetic material among desert pupfish populations.	0.8
5. Monitor and maintain natural, re-established, and refugium populations.	1.7
6. Determine factors affecting population persistence.	0.0
7. Information and education.	1.3

Current Status in Gila River basin

Three established wild populations plus three recently stocked populations. Numerous captive populations in school ponds and other locations.
USFWS (2004) reports range-wide status as stable.

Review of 5 Listing Factors

Factor	At time of listing (1986)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Reduced and localized distribution due to past habitat modification (dams, diversions, pumping) and erosion, continuing loss and modification of habitat (groundwater pumping, changes in water conveyance facilities, conversion to agriculture, oil and gas development), competition and predation by nonnative fishes, pesticide contamination.	Similar. Increased water use. Increased threat from nonnative fishes.
2. Overutilization for commercial, sporting, scientific or educational purposes.	Minor take by bait fish seiners and aquarists.	Similar across range, but unlikely in Gila River basin due to lack of populations.
3. Disease or predation.	Spread and introduction of nonnative fishes.	Similar. Introduction and spread of parasites and novel fishes, including Asian tapeworm and inland silverside.
4. Inadequacy of existing regulations.	Inadequacy of state and Mexican laws for protection of the fish or its habitats.	Similar.
5. Other natural or manmade factors affecting its continued existence.	Introduction, spread, and control methods of aquatic plant hydrilla *Hydrilla verticillata* in canals.	Similar. Introduction, spread, and control methods of giant salvinia S*alvinia molesta*. Extended drought may be affecting some populations.

Bonytail
Gila elegans

Bonytail was listed as endangered in 1980, and a recovery plan approved in 1984, revised in 1990, and recovery goals supplemented in 2002 (USFWS 1980, 1984a, 1990, 2002a). Critical

habitat was designated in 1994 (USFWS 1994b). The short-term recovery goal was to prevent extinction and the long-term recovery objective was down listing and delisting. The recovery plan projected the species would be saved from extinction in the upper Colorado River basin by 2003. A recovery date for the lower Colorado River basin and quantitative goals for downlisting and delisting were put off until more information could be obtained. The supplement provided quantitative goals that clearly reflected biological information. Long term recovery objectives included development and maintenance of two self-sustaining populations of >4,400 adults each in the lower Colorado River mainstem and/or tributaries. In the supplement, USFWS projected the species could be proposed for downlisting in 2020, and proposed for delisting in 2023. These estimates were based on a time frame of 15 years to establish a self-sustaining population once the number of adults in a population reached 4,400 individuals, with self-sustaining defined as maintenance of that population level for 5 years for downlisting and an additional 3 years for delisting. Delisting also required two self-sustaining populations in the lower basin maintained over a 3-year period after downlisting. Gila River basin streams were not addressed, although they are potentially available.

Historical distribution of bonytail in the Gila River basin included low to intermediate reaches of the mainstream Gila, Salt, and Verde rivers. It no longer occurs anywhere in the Gila River basin.

Five tasks with 27 subtasks were described in the recovery plan, and 20 subtasks assigned to five listing factors in the supplement (Appendix: bonytail). Recovery actions in the lower Colorado River basin (including Gila River) were not addressed in the recovery plan, but were in the supplement. Recovery in Gila River basin streams was not considered in either the recovery plan or the supplement (Table 3). There have been no recovery efforts for bonytail in the Gila River basin.

Threats to the species identified at time of listing continue today unabated. Habitat has been lost due to water manipulations and invasion and spread of nonnative species, limiting recovery potential. Nonnative parasites and fishes continue to invade and spread though the waters of the basin. The Verde and Salt rivers have special angling regulations designed for the enhancement of native fishes. Although these are unlikely to have any significant direct influence on the native fishes, their primary utility is in public education. Bonytail appears to be a “forgotten” species in the native fish assemblage of the Gila River basin. Management attention is absent.

There have been stockings of hatchery-produced fish to perpetuate remnant populations in mainstream Colorado River reservoirs, but no attempts have been initiated to develop self-sustaining populations in the lower Colorado River basin to date. The criteria for downlisting bonytail cannot be met by 2020. USFWS (2004) assessed 0-25% achievement of recovery objectives range-wide for bonytail. Recovery actions in the Gila River basin were not addressed in the recovery program, but also were not precluded if lower basin agencies chose to implement recovery activities. However, since this is unlikely to occur bonytail will remain lost from the Gila River basin assemblage until the recovery plan and goals are changed.

Table 3. Summary of status review findings for the bonytail relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Tasks from recovery plan	Average subtask score

1. Prevent extinction of bonytail chub in the wild.	N/A
2. Obtain essential information on the life history and habitat requirements of the bonytail chub.	N/A
3. Resolve taxonomic problems in Colorado River basin *Gila.*	N/A
4. Promote and encourage improved communication and information dissemination	N/A
5: Develop quantitative recovery goals and a long-term habitat protection strategy	N/A
Factors from supplement to recovery plan	
A. Adequate habitat and range for recovered populations provided.	N/A
B. Protection from over utilization for commercial.	N/A
C. Adequate protection from diseases and predation.	N/A
D. Adequate existing regulatory mechanisms.	N/A
E. Other natural or manmade factors for which protection has been provided.	N/A

Current Status in Gila River basin

No wild populations exist.
USFWS (2004) reports range-wide status as uncertain.

Review of 5 Listing Factors

Factor	At time of listing (1980)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss and modification of habitat and alteration of water temperature due to impoundments and diversions, loss of instream flows and dewatering by irrigation, interspecific competition with nonnative fishes.	Similar.
2. Overutilization for commercial, sporting, scientific or educational purposes.	N/A.	Similar.
3. Disease or predation.	Predation by nonnative fishes.	Similar. Introduction and spread of nonnative parasites and fishes, including Asian tapeworm and inland silverside.
4. Inadequacy of existing regulations.	N/A.	Similar.
5. Other natural or manmade factors affecting its continued existence.	N/A.	Recovery plan does not directly address recovery in Gila River basin streams.

Gila chub
Gila intermedia

Gila chub was listed as endangered with critical habitat in 2005 (USFWS 2005a). A recovery plan has not yet been prepared, nor has a recovery team been appointed.

Gila chub is a Gila River basin endemic species. Historically, it occupied upper reaches of small- and middle-sized streams, including all major tributaries. It currently is known from fewer than 30 small and isolated streams and spring systems scattered throughout the basin (Table 4).

The primary threats to Gila chub include predation by and competition with nonnative organisms, particularly fish in the family Centrarchidae (*Micropterus* spp., *Lepomis* spp.), bullfrogs *Rana catesbeiana*, and crayfish (e.g., *Orconectes virilis*), and habitat degradation from surface water diversions and ground water pumping. Secondary threats include habitat alteration, destruction, and fragmentation resulting from numerous anthropogenic factors. Natural threats include drought, flood, and wildfire.

Recent conservation activities have included removal of nonnative fishes from occupied habitats followed by repatriations of Gila chub (Sabino, Romero, O'Donnell, and Bear canyons), translocations into historical habitats (Turkey Creek), removal and transport to hatcheries during emergency situations with subsequent repatriation (Indian Creek), and development of hatchery propagation techniques. Similar efforts will likely be included in any recovery plan prepared for the species. Arnett Creek was renovated and a barrier constructed in the 1990's for repatriation of native fishes, including Gila chub. Due to long-term drought, stream conditions there have not been suitable for fish.

Table 4. Summary of status review findings for the Gila chub relative to recovery in the Gila River basin, current status, and review of listing factors.

Current Status in Gila River basin		
Less than 30 isolated populations in wild.		
Review of 5 Listing Factors		
Factor	At time of listing (2005)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss and alteration of wetland, riparian, and cienega habitats; increased human population growth with concurrent increase in demand for water; channelization, livestock grazing; mining; increases in road density; increased recreational activities.	Similar.
2. Overutilization for commercial, sporting, scientific or educational purposes.	Angling or collection of Gila chub is prohibited by state regulation throughout its range. Incidental take by angling is unlikely as most chub populations do not occur in popular fishing waters.	Similar.
3. Disease or predation.	Introduction and spread of nonnative fishes and other aquatic organisms, including Asian tapeworm, anchor worm, and "Ich" *Ichthyophthirius multifiliis*.	Similar.
4. Inadequacy of existing regulations.	Use of live bait in waters confluent with Gila chub habitats is permitted, and may allow for introduction of nonnative species. Inter-state movement of nonnative and chemical pollutants poorly regulated. Limited habitat protection by States and inadequate protection of streamflows.	Similar.
5. Other natural or	Fragmentation and isolation increases vulnerability to	Similar. Extended

manmade factors affecting its continued existence.	random events (e.g. drought, floods, and wildfire), nonnative competition and predation, and inbreeding depression. Human alterations to watersheds, channels, and hydrologic regime have increased adverse impacts from drought and flooding. Contaminants in water.	drought adversely affecting several populations.

Spikedace

Meda fulgida

Spikedace was listed as threatened in 1986, and an approved recovery plan issued in 1991 (USFWS 1986c, 1991d). Critical habitat was designated twice: the first effort was invalidated and the second vacated by Federal court order due to policy issues and inadequacy of economic analyses. Both were remanded to USFWS to complete in accordance with ESA regulations. Critical habitat was proposed for a third time in December 2005 (USFWS 1994a, 1998a, 2000b, 2005b), but omitted unoccupied streams that had potential to support reintroduced populations (47% of the area designated in 2000). The recovery objective was protection of existing populations and restoration of populations in portions of historical habitat, which would lead to delisting. The recovery plan did not provide quantitative criteria for recovery, nor describe clearly how the subtasks related to biological needs of the species. Direction to develop criteria for self-sustaining populations was provided. The recovery plan estimated that delisting could not occur in less than 20 years from date of plan approval (i.e., 2011). The plan has not been reviewed.

This species is endemic to the Gila River basin, where it historically occupied low- and intermediate-elevation streams including all major tributaries except the Santa Cruz River. Populations are currently sustained in eight streams, but nearly all are declining in abundance and range, some to the point of non-detection for many years.

The recovery plan identified seven tasks and 78 subtasks (Appendix: spikedace). Of the subtasks, 19 were considered priority 1, 40 were priority 2, and 19 were priority 3 (Table 5). Initiation of subtasks for recovery of spikedace was high. Seventeen (89%) of the priority 1 subtasks, 21 (53%) of the priority 2, and 12 (75%) of the 12 applicable priority 3 subtasks have been initiated. However, average subtask scores indicate that progress toward completion of subtasks is low. In some cases this does not reflect inaction but rather a lack of successful outcome; for example, designation of critical habitat (a priority 1 subtask) has been done twice, but rescinded twice (once each by court order and agency direction). In other cases, the low scores for initiated subtasks are because planning has been done, but no or few actions have taken place. All occupied habitats have had some level of protection provided (Task 1), but a significant level of adverse impact from human activities has still occurred. Designation of critical habitat would give additional emphasis to ensuring that land and water use practices sensitive to needs of loach minnow were implemented, and to acquisition of private lands and water rights. Grazing was curtailed along much of occupied habitat on U.S. Forest Service lands in response to a lawsuit. Most populations are being monitored on a regular basis (Task 2), but not to the standards of the recovery plan. Interactions with nonnative fishes (Task 3) have been poorly studied; however, existing evidence strongly suggests that when nonnative fishes invade occupied habitats, spikedace decline in abundance. A few studies have been completed on habitat needs (Task 4), but there has been no synthesis attempted. Identification of occupied habitats in need of enhancement has been done (Task 5), but improvement projects weakly initiated. Suitable repatriation habitats and stocks to use have been identified (Task 6), but no repatriations have been attempted since spikedace was listed. With few exceptions,

quantitative criteria for self-sustaining populations (Task 7) have not been developed. Captive holding, propagation, and holding techniques (Task 8) have been developed, but not put to use. Information and education efforts (Task 9) have mostly consisted of information about native fishes in general, and dispersal of trinkets (pencils and pens, key fobs, refrigerator magnets, etc.) and brochures.

Threats to the survival of spikedace have amplified since it was listed. Populations in several occupied habitats have declined to the point where detection during monitoring may be years or decades apart. Spread and abundance of nonnative predacious fish and other aquatic species has increased in several occupied habitats, groundwater pumping is increasing in aquifers that supply water to the upper Verde River and elsewhere, and the incidence of Asian tapeworm in other co-occurring species is increasing. Inland silverside may pose a threat to spikedace if it spreads to occupied waters. Arizona Game and Fish Commission has promulgated regulations in the Salt and Verde rivers designed to reduce the presence of nonnative fishes, however these are unlikely to have any significant effect on abundance of spikedace. Recovery habitats, unprotected by critical habitat or other regulatory mechanism, continue to suffer degradation, such as the flow reductions in the upper San Pedro River due to groundwater pumping. Renewed interest in storage and diversion of water from the upper Gila River reopens a continuing threat to existence of the species in New Mexico.

In general, subtasks that required no or minimal on-the-ground action were implemented, whereas others that were more complex or controversial were not. USFWS (2004) reported 0-25% achievement of recovery objectives for spikedace. We considered achievement of recovery goals to be low. Nonetheless, there have been some on-the-ground actions taken in support of habitat improvement for the species. Hundreds of miles of stream courses available to spikedace were fenced to exclude livestock grazing, but how spikedace may respond to improved riparian conditions is uncertain, especially in light of increasing presence of nonnative species, and is not being studied other than through monitoring. The status of the species has deteriorated significantly since listing, and a formal petition finding has concluded that spikedace warrants uplisting to endangered.

Table 5. Summary of status review findings for the spikedace relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Task	Average subtask score
1. Protect existing populations of spikedace.	2.0
2: Monitor status of existing populations.	1.7
3. Identify nature and significance of interaction with nonnative fishes.	0.8
4. Quantify, through research, spikedace habitat needs and the effects of physical habitat modification on life cycle completion.	0.7
5. Enhance or restore habitats occupied by depleted populations.	1.6
6. Reintroduce populations to selected streams within historic range.	1.4
7. Determine quantitative criteria for describing a self-sustaining population.	0.1
8. Plan and conduct investigations on captive holding, propagation and rearing.	1.9
9. Information and education.	1.4
Current Status in Gila River basin	

Population in Aravaipa Creek is apparently healthy, but range may be contracting on west end. The remaining seven populations are declining, some to the point of no recent detection. USFWS (2004) reports status as declining.

Review of 5 Listing Factors

Factor	At time of listing (1986)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss or alteration of habitat due to impoundments, diversions, groundwater pumping, channel downcutting, channelization, riparian vegetation destruction, erosion, mining, grazing, and watershed disturbances, alteration of flow regimes and elimination of natural flooding patterns, alteration of water temperatures, alteration of silt and bed loads, loss of marshes and backwaters, alteration of natural stream course characteristics. Planned dam construction on upper Gila River and water diversion on upper Verde River.	Similar. Dam on upper Gila not constructed but planning has been renewed for water development and diversion. Diversion on upper Verde River replaced by groundwater pumping. Increasing urban and exurban development of watersheds.
2. Overutilization for commercial, sporting, scientific or educational purposes.	No threat.	Similar.
3. Disease or predation.	Introduction and spread of nonnative predatory fishes.	Similar, but with rapid increase in range and abundance. Introduction and spread of Asian tapeworm.
4. Inadequacy of existing regulations.	State laws prohibit take, but do not provide protection of habitat; state water laws do not protect instream flows; state laws allow use of bait fish (e.g., red shiner *Cyprinella lutrensis*) in occupied habitat.	Similar, but State angling regulations for Salt and Verde rivers revised in favor of native fishes. Lack of State laws protecting surface water from groundwater withdrawals.
5. Other natural or manmade factors affecting its continued existence.	Introduction and spread of red shiner combined with disturbance of natural flooding patterns.	Similar. Increasing demand for water for domestic use. Extended drought adversely affecting populations. Population declines in most streams. Extended drought affecting populations.

Woundfin

Plagopterus argentissimus

Woundfin was listed as endangered in 1970; a recovery plan was produced in 1979, and revised in 1984 and 1995 (USFWS 1970, 1984b, 1995). The latest revision included Virgin River chub *Gila seminuda*[4] and was titled "Virgin River Fishes Recovery Plan." Critical habitat

[4] Virgin River chub is endemic to the Virgin River system of Utah-Arizona-Nevada.

was designated in 2000 (USFWS 2000a). The primary recovery objective was to prevent the extinction of woundfin, and then secure its survival. The long-term goal was downlisting, which did not include any activities in the Gila River basin. Downlisting criteria were not quantitative, and somewhat unclear as to how they related to the biological needs of the species. The recovery criteria for delisting directed establishment of additional self-sustaining populations, but development of quantitative criteria to describe self-sustaining populations was put off until more information became available. As with downlisting criteria, relationships between delisting criteria and biological needs of the woundfin were unclear. Downlisting of woundfin to threatened status was expected to occur by 2015. Delisting was not certain to ever be possible, but interim delisting criteria were given. For delisting, two additional self-sustaining populations must be established for at least 10 consecutive years within the historical range, which could include potential mainstem sites in Gila, San Francisco, Hassayampa and Verde rivers, and Tonto Creek, subject to their withdrawal from the experimental-nonessential designation put in place in 1985.

Within the Gila River basin, woundfin historically occurred from near the confluence of the Salt and Verde rivers to the mouth of the Gila River and likely in confluent streams within that reach. It no longer occurs anywhere in the Gila River basin.

The recovery plan listed five tasks, but only Tasks 3 and 5 applied to populations and habitats outside the Virgin River system (Appendix: woundfin). Five subtasks were associated with Task 3, and two have been initiated (Table 6). The average subtask score for Task 3 reflects that no on-the-ground activities for the reintroduction of woundfin have been done. Hatchery stocks of woundfin are established, progeny are seasonally available, and genetic questions are resolved. But other prerequisites for reintroductions into Gila River basin waters have not been addressed and no reintroductions have been attempted although this direction was in the original woundfin recovery plan produced nearly three decades ago. Additionally, direction to reestablish woundfin in Tonto Creek, and Gila, San Francisco, Verde, and Hassayampa rivers as experimental-nonessential populations under Section 10j of ESA was never initiated. Task 5 involved public information and education, which has not been initiated in the Gila River basin.

Threats to woundfin have remained much the same since its listing 36 years ago. The original listing did not describe threats to the species. Subsequent documents for critical habitat and the recovery plan discussed threats to the species. In the Gila River basin, the unchecked spread of nonnative fishes precludes reestablishment of woundfin without renovation efforts in potential restoration streams.

Range-wide, USFWS (2004) estimated that only 0-25% of the recovery objectives for woundfin have been accomplished. We estimated achievement of recovery goals in the Gila River basin to be minimal, and restricted to a few planning efforts with no on-the-ground progress. Downlisting by 2015 will not be realized because reintroductions required for downlisting to be proposed have not occurred and at least 10 years are needed to document the success and stability of reintroduced populations.

Table 6. Summary of status review findings for the woundfin relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Task	Average subtask score
1. Maintain and enhance native fish communities of the Virgin River	N/A

chub and woundfin.

2. Protect and enhance habitat for the native Virgin River fish communities	N/A
3. Establish additional populations of woundfin and Virgin River chub within their historic range.	0.7
4. Determine ecological requirements of native Virgin River fishes with emphasis on woundfin and Virgin River	N/A
5. Develop and implement educational and informational programs highlighting recovery needs and ongoing efforts for Virgin River fishes.	0.0

Current Status in Gila River basin

No wild populations exist.
USFWS (2004) reports range-wide status as declining.

Review of 5 Listing Factors

Factor	From recovery plan (1995)[5]	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss from significant portion of historical range. Deteriorating conditions in occupied habitats. Water development (diversion, impoundment, groundwater pumping); urban/suburban development; channelization; watershed alteration. Fragmentation of range. Alterations to natural flow, temperature, and sediment regimes.	Similar. Increased urbanization resulting in increased water use and diversion, and loss of floodplains.
2. Overutilization for commercial, sporting, scientific or educational purposes.	None noted.	Similar.
3. Disease or predation.	Introduction and spread of nonnative species, particularly red shiner, in occupied habitats.	Similar. Spread of extant predatory and competitive nonnative aquatic species. Introduction and spread of nonnative parasites and fishes, including Asian tapeworm and inland silverside.
4. Inadequacy of existing regulations.	State and Federal laws inadequate to control habitat destruction or nonnative introduction and spread. Lack of State laws protecting surface water from groundwater withdrawals.	Similar. Experimental-nonessential reintroductions in Gila, Verde, San Francisco, and Hassayampa rivers, and Tonto Creek never implemented.
5. Other natural or manmade factors affecting its continued existence.	Highly reduced distribution and numbers, along with fragmentation increase adverse effects of drought and flooding.	Similar. Urbanization and loss of floodplains.

[5] Listing factors were not addressed in the 1970 rule.

Gila topminnow

Poeciliopsis occidentalis

Gila topminnow was listed in 1967 and a recovery plan written in 1984 (USFWS 1967, 1984c). There is no designated critical habitat. The recovery plan was redrafted (USFWS 1999), and is being used to guide most ongoing recovery efforts for Gila topminnow, although not yet approved. Recovery goals and tasks of the redraft are similar to the 1984 recovery plan, but the criteria for recovery are considerably different. The primary goal of the 1984 recovery plan was delisting, to be accomplished by ensuring the survival of Gila topminnow through protection of existing stocks and establishment of new populations. Projected timeframes for recovery were dependent on reestablishment of wild populations; survival of natural populations was not a part of the recovery criteria. Quantitative recovery goals were given, but how they related to biological needs of the species was unclear. Downlisting could occur when twenty populations had been reestablished and had survived for at least 3 years. Delisting could occur when fifty populations had been reestablished and survived for at least 3 years, or thirty populations had survived for at least 5 years.

The redrafted recovery plan included protection and establishment of refuge stocks of natural populations as part of recovery criteria, and projected recovery to threatened status to take 20 years. In addition to protection of the then extant 14 natural sites (Level 1 sites), reestablishment into at least 20 sites and their survival for at least 10 years (Level 2 sites), plus reestablishment into an unspecified number of sites with lesser survival time (Level 3 sites) was directed for downlisting. Delisting was not addressed. Quantitative criteria for describing established populations were provided, and were clear in their relationships to the biological needs of the species. No date for recovery was projected in the redraft. To date the redraft has not been approved, primarily due to agency disagreement with recovery criteria. The Desert Fishes Recovery Team, which oversaw development earlier versions of the redraft and formulated recovery criteria, was disbanded. A new version of the redraft has been prepared with only USFWS and Arizona Game and Fish Department (AGFD) input. Written requests by several non-agency experts to participate in this revision and for appointment of a Gila topminnow recovery team have been rejected by USFWS. The 1984 recovery plan is the only approved plan for Gila topminnow and we have used it for this analysis. Listed tasks and subtasks in the redraft are provided for comparison purposes, but not analyzed for implementation.

Historical range of Gila topminnow included virtually all waters (streams, springs, cienegas, backwaters, and margins of larger rivers) within the Gila River basin below about 5,000 feet elevation. Current range includes about 14 known natural populations, and about nineteen reestablished populations[6]. The current range of Gila topminnow in the Gila River basin is an infinitesimal portion of its historical range, is highly fragmented with little or no opportunity for natural movement of fish between sites, and most sites are small, and highly vulnerable to environmental perturbations.

The recovery plan included seven tasks with 44 subtasks (Appendix: Gila topminnow). Seven subtasks were priority 1 and six of these (86%) have been initiated (Table 7). Eleven (85%) of 13 priority 2 subtasks have been initiated, as have 21 (88%) of 24 priority 3 subtasks. Although the percentage of subtasks initiated is high, extent of implementation is low.

[6] Exact numbers of populations are difficult to ascertain due to survey methods and time of year of survey, counting approaches (e.g., Bylas Spring may be counted as one, two, or three sites), or whether a site meets extirpation criteria, etc.

Low subtask scores for tasks 1 and 4 primarily reflect continued invasion and replacement of Gila topminnow by western mosquitofish *Gambusia affinis* and the small number of reintroduction efforts during the past two decades. For example, the extant natural sites identified in the original recovery plan have been supplemented by the discovery of additional populations. However, there has been no net gain, because Gila topminnow has been replaced by western mosquitofish or completely or mostly eliminated by a combination of factors in several of those natural sites, and western mosquitofish are present in others. Use of mosquitofish as bait has been curtailed by regulation in some of the Gila River basin. Surveys for undiscovered populations (Task 2) have added to the list of natural populations. Stocks of Gila topminnow (Task 3) are held at Dexter National Fish Hatchery and Training Center (Dexter NFH&TC) and at Arizona State University (ASU). Studies on Gila topminnow (Task 5) have concentrated on genetic relationships. Few biological studies have been done since time of listing as much of this information was obtained prior to listing. Enforcement of state and federal laws (Task 6) has been variable and oftentimes politically manipulated. Information and education efforts (Task 7) are primarily done through stocking of ponds at schools, visitor centers, zoos, and gardens. A brochure specific to Gila topminnow and desert pupfish was produced for public dissemination.

Recovery efforts in both the approved recovery plan and the redraft emphasized the need for a continuing program of reestablishment of Gila topminnow populations in the wild. During 1982-85, 108 wild sites were stocked with Gila topminnow, an effort that resulted in eight currently extant populations (7.8% survival rate). However, the stocking program languished during the next two decades. Two dozen reintroductions have been made since 1986, but only a few of those survived for more than a year. Numerous other sites were identified for stocking with Gila topminnow during the past 20 years, but not accomplished. Currently there are approximately eleven Level 2 and nine Level 3 sites, but many of these do not meet other criteria necessary to count toward recovery. One reason for the high rate of failure of recently stocked sites is that the most promising sites are often deemed off-limits to the recovery program by management agencies, and the only sites permitted to be stocked are of lesser quality. The stocking program should be reinitiated as recommended in the revised draft recovery plan. Stocks of Gila topminnow are available for repatriation, and progeny are obtainable nearly year round. Genetic issues are resolved, and all that is lacking is leadership that would direct an aggressive program for establishment in wild habitats.

Threats to survival of the species have diminished somewhat since it was listed, primarily due to the reestablishment program which has increased the number of wild occupied sites. However, many of the sites in the wild are contaminated with western mosquitofish, which will lead to demise of the Gila topminnow without management intervention. Chemical renovation to remove western mosquitofish from complex habitats in other areas of the southwest has been largely unsuccessful, and has not been attempted in Gila River basin habitats. Groundwater pumping, even in remote areas, can deplete surface water conditions to a point that extended drought can eliminate a population, as is happening in Redrock Canyon. The biggest threat is the lack of management emphasis for reestablishment of additional populations and for removal of nonnative species from occupied habitats.

USFWS (2004) reported 0-25% achievement of recovery objectives for Gila topminnow. We consider that achievement of recovery objectives for Gila topminnow has been low to moderate. At the current rate of reestablishing populations (~23 attempts in the past 20 years with a survival rate of <10%) it is unlikely that recovery goals for downlisting will be accomplished. Recently, a “Safe Harbors Agreement” designed to encourage the use of Gila topminnow for mosquito control in artificial habitats has been drafted, but not approved. Notwithstanding,

reintroduction efforts for Gila topminnow are at a standstill.

Table 7. Summary of status review findings for the Gila topminnow relative to recovery in the Gila River basin, current status, and review of listing factors (1984 recovery plan). Tasks from the draft revised recovery plan are provided for comparison purposes, but were not analyzed for implementation. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Tasks from recovery plan	Average subtask score
1. Maintain, protect and enhance existing natural populations and habitats of the Gila and Yaqui topminnow.	1.7
2. Continue surveying waters in the Gila River drainage and United States portion of the Yaqui River drainage for undiscovered populations of topminnow.	2.4
3. Maintain stocks of Gila and Yaqui topminnow at Dexter NFH&TC&TC.	2.2
4. Reintroduce Gila and Yaqui topminnow into suitable sites within the United States portion of their historic ranges.	2.0
5. Initiate and support further studies of the Gila and Yaqui topminnow.	0.0
6. Enforce all State and Federal laws protecting topminnow populations and their habitat.	2.3
7. Develop public support through an information and education program.	1.6

Tasks from draft revised recovery plan (1999)

1. Prevent extinction by protecting remaining natural and long-lived reestablished populations.
2. Reestablish and protect populations throughout historic range.
3. Monitor natural and reestablished populations and their habitats.
4. Develop and implement genetic protocol for managing populations.
5. Study life-history, genetics, ecology, and habitat of Gila topminnow and interactions with nonnative aquatic species.
6. Inform and educate the public and resource managers.

Current Status in Gila River basin

About 14 natural populations exist but several also contain western mosquitofish.
About 19 reestablished populations.
USFWS (2004) reports status as declining.

Review of 5 Listing Factors

Factor	At time of recovery plan (1984)[7]	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss or alteration of habitat due to impoundments, diversions, groundwater pumping, channel downcutting, channelization, riparian vegetation destruction, erosion, mining, grazing, and watershed disturbances, alteration of flow regimes and elimination of natural flooding patterns, alteration of water temperatures, loss of marshes and backwaters, alteration of natural stream course characteristics.	Similar. Most losses have been reduced, though not for all areas. Livestock grazing managed better at almost all populations.
2. Overutilization for commercial, sporting, scientific or educational	None identified.	Similar.

[7] Listing factors were not addressed in the 1967 rule.

purposes.

3. Disease or predation.	Predation and competition with nonnative fish was a major factor leading to the demise and listing of the Gila topminnow. Western mosquitofish are especially problematic.	Similar. Introduction and spread of nonnative parasites and fishes, including Asian tapeworm and inland silverside.
4. Inadequacy of existing regulations.	A lack of site-specific plans for existing populations was an issue.	Similar. Most sites still lack specific plans.
5. Other natural or manmade factors affecting its continued existence.	Lack of awareness about the conservation needs of native fishes.	Similar. Awareness is better, but still problematic. Agency, landowner, and lessees are resistant to reintroduction efforts. Extended drought affecting populations.

Colorado pikeminnow
Ptychocheilus lucius

Colorado squawfish (=Colorado pikeminnow[8]) was listed as endangered in 1967. A recovery plan was written in 1978, revised in 1991, and in 2002 recovery goals were amended and supplemented (USFWS 1967, 1991a, 2002b). Critical habitat was designated in 1994 (USFWS 1994b). The recovery plan and revision noted the need for maintenance of self-sustaining populations in both the upper and lower Colorado River basins. Recovery goals in the 2002 amendment and supplement eliminated the requirement to establish a lower basin population, instead asserting that the need for a lower basin self-sustaining population would be "…reevaluated at the status review of the species, which is conducted at least once every 5 years." The 2002 amendment and supplement predicted that downlisting could be proposed in 2006 and delisting in 2013, apparently with no consideration for a lower basin population.

In the Gila River basin, Colorado pikeminnow occurred throughout the Gila River and its tributaries, including San Pedro, Salt, and Verde rivers, and likely ranged into the smaller tributaries also. The last record of a wild Colorado pikeminnow from a Gila River basin stream was in 1950. Hatchery-reared Colorado pikeminnow were stocked into the Salt and Verde rivers and some of their tributaries beginning in the early 1980's, and any population established was considered to be experimental-nonessential. Initial stockings were unsuccessful due to predation by nonnative fishes on the small fishes released. Salt River stocking was discontinued after 1989. Later efforts (post 1991) released fish greater than 300 mm in length into the Verde River. There have been few recaptures in the Verde River and those mostly a few months after stocking. No fish have been recaptured in the Salt River.

The recovery plan identified four tasks with 41 subtasks (Appendix: Colorado pikeminnow). Tasks 1 and 2 did not apply to the Gila River basin. Tasks 3-5 included three priority 1, two priority 2, and seven priority 3 subtasks applicable to the lower basin. All of the priority 1 and 2 subtasks have been initiated (Table 8), and six of the seven priority 3 subtasks. However, the average subtask score was low because factors that limit success of the stocking program have

[8] The common name of Colorado squawfish was changed by the American Fisheries Society to Colorado pikeminnow in 1998.

not been addressed. Predation on Colorado pikeminnow by nonnative fish has been clearly identified as the causative factor in restricting success, but no attempts to remove nonnative fish from sites for stocking have been made. Other than stocking (Task 3), little effort has been expended on recovery for Colorado pikeminnow in the Gila River basin. Hatcheries are producing fish of appropriate genetic stocks and sizes, and regular monitoring takes place. Special regulations for angling on the Salt and Verde rivers have been promulgated to protect Colorado pikeminnow, but these are mainly for public information (Task 4). Quantitative objectives for down- and delisting Colorado pikeminnow (Task 5) were provided in the supplement to the recovery plan, but did not consider the lower basin. Much of the historical range of Colorado pikeminnow was in the lower basin, including the Gila River basin, thus the recovery criteria do not reflect the biological needs of the species.

Threats from nonnative fish continue to be problematic. In the Salt River, the relative abundance of flathead catfish *Pylodictus olivaris* has increased from less than 5% of the fish captured during monitoring in 1981, to 90% in recent surveys. Flathead catfish are established in the Verde River. However, many other predators, particularly centrarchids (spiny-rayed fish), are present and prey on stocked Colorado pikeminnow. The upper Gila River in Arizona holds potential for Colorado pikeminnow, but only if nonnative fish populations are reduced or eliminated. One of the largest impediments to recovery activities for Colorado pikeminnow in the Gila River basin is the lack of commitment by management agencies to a nonnative fish control program. Goals established by USFWS in the supplement consider recovery "...necessary only in the upper basin because of the present status of populations and because existing information on Colorado pikeminnow biology support application of the metapopulation concept to extant populations." This philosophy generates cascading effects: 1) the recovery program does not recognize lower basin as necessary to the recovery effort, therefore 2) management emphasis and money must be expended on higher priority species, which 3) ensures that Colorado pikeminnow does not have a recovery program in the lower basin, resulting in 4) an unsupportable conclusion that the lower basin could not support a population.

Recovery to downlisting status does not include requirements to establish Colorado pikeminnow in the Gila River basin. USFWS (2004) assessed that 51-75% of recovery goals had been achieved range-wide. Our estimate considers that achievement of goals has been only low to moderate in the Gila River basin, and of supplemental goals nil. Modifications of the stocking program have been suggested to increase post-release survival, but not implemented. Construction of "grow-out" ponds along the Verde River could be considered, as could use of Fossil Creek as a "grow-out" facility. Seasonal removal of nonnative fish from the upper Verde River and tributaries could increase survival of stocked fish. USFWS expects to determine the need for a lower basin population in delisting during 5-year status reviews for the species.

Table 8. Summary of status review findings for the Colorado pikeminnow relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Tasks from the recovery plan	Average subtask score
1. Monitor population status and define the life history requirements of the Colorado squawfish.	N/A
2. Develop and implement management plans to protect and maintain Colorado squawfish populations and their habitat	N/A
3. Reintroduce Colorado squawfish into their historic range.	1.6
4. Promote and encourage improved communication and information dissemination.	1.0

5. Determine biological criteria/objectives for down listing/delisting the Colorado squawfish.	3.1

Factors from the amendment and supplement	Average subfactor score
A. Provide flows necessary for all life stages of Colorado pikeminnow to support recovered populations, based on demographic criteria.	N/A
B. Protect Colorado pikeminnow populations from over utilization for commercial, recreational, scientific, or educational purposes.	N/A
C-1. Minimize adverse effects of diseases and parasites on Colorado pikeminnow populations.	N/A
C-2. Regulate nonnative fish releases and escapement into the main stem, floodplain, and tributaries.	N/A
C-3. Control problematic nonnative fishes as needed.	N/A
D-1. Legally protect habitat necessary to provide adequate habitat and sufficient range for all life stages of Colorado pikeminnow to support recovered populations, based on demographic criteria.	N/A
E. Other natural or manmade factors for which protection has been provided.	N/A

Current Status in Gila River basin

No wild populations exist, although stocking of subadults into Verde River continues.
Stocking discontinued into Salt River after 1990.
USFWS (2004) reports range-wide status as improving.

Review of 5 Listing Factors

Factor	At time of recovery plan (1991)[9]	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Construction of dams and diversions fragmented populations. Changes in physical and biological conditions below dams (channelization, altered discharge regimes and temperatures)	Similar. Much historic habitat now drained or dried. Remaining threatened by water development, mining, grazing, roads, recreation, erosion, watershed alteration, etc.
2. Overutilization for commercial, sporting, scientific or educational purposes.		Special angling regulations and I&E program in place on Salt and Verde rivers.
3. Disease or predation.	Spread of extant nonnative fishes, and introduction and spread of novel nonnative fishes.	Similar. Introduction and spread of nonnative parasites and novel fishes, including Asian tapeworm and inland silverside. Exacerbated by drought.
4. Inadequacy of existing regulations.		Lack of habitat protection. Inability to protect habitats for recovery or when temporarily unoccupied. Lack of State laws protecting surface water from groundwater withdrawals.
5. Other natural or manmade factors affecting its continued		Lack of direction for Gila River basin recovery efforts in recovery goals.

[9] Listing factors were not addressed in the 1967 rule.

existence.

Loach minnow

Tiaroga cobitis

Loach minnow was listed in 1986 as threatened and a recovery plan approved in 1991 (USFWS 1986b, 1991c). Critical habitat was designated twice: the first effort was invalidated and the second vacated by Federal court order due to policy issues and inadequacy of economic analyses. Both were remanded to USFWS to complete in accordance with ESA regulations. Critical habitat was proposed for a third time in December 2005 (USFWS 2005b), but omitted unoccupied streams that had potential to support reintroduced populations (51% of the area designated in 2000). The recovery objective was delisting through protection of existing populations and restoration of populations into historical habitats. No quantitative recovery criteria were stated, and the relationship of the needs of the loach minnow to the recovery goals was not clearly defined. Date of recovery for loach minnow was projected to be no less than 20 years post-recovery plan or 2011. The recovery plan has not been reviewed.

Loach minnow is endemic to the Gila River, where it historically occupied low- and intermediate-elevation streams including all major, and many minor tributaries except the Santa Cruz River. Populations are currently sustained in approximately eleven streams, and most are declining in abundance and range.

The recovery plan identified nine tasks and 77 subtasks with 19 priority 1, 40 priority 2, and 18 priority 3 subtasks (Appendix: loach minnow). All priority 1, 25 (63%) priority 2, and 12 (80%, three were not applicable) priority 3 subtasks have been initiated (Table 9). However, accomplishment of subtasks is low, due to both inaction and lack of successful outcome. Protection of existing populations (Task 1) would have a higher score if critical habitat were designated. Designation would give additional emphasis to ensuring that land and water use practices sensitive to needs of loach minnow were implemented, and to acquisition of private lands and water rights. Grazing was curtailed along much of occupied habitat on U.S. Forest Service lands in response to a lawsuit. Although most populations of loach minnow are being monitored regularly (Task 2), there is no all-encompassing monitoring effort. The Desert Fishes Recovery Team, which formerly provided this direction, was disbanded and has not been replaced by any similar group. Very few laboratory studies or field investigations have examined the relationships between loach minnow and nonnative fishes (Task 3); however, existing evidence strongly indicates that healthy populations of loach minnow are not compatible with presence of nonnative fishes. Use by loach minnow of various parameters of the physical environment (Task 4), and reactions of loach minnow to changes in those parameters have not been investigated fully. Initiation of projects for enhancement of loach minnow habitat has not occurred (Task 5). Suitable streams have been identified for reintroduction of loach minnow (Task 6), but only Fossil Creek has been made ready. Based on monitoring data and analysis, Task 7 is probably an elusive goal for loach minnow. Hatchery propagation techniques have been investigated and hatcheries are available to propagate loach minnow for reestablishment efforts (Task 8). Dissemination of scientific data and management information (Task 9) was severely compromised with the disbanding of the Desert Fishes Recovery Team. Other efforts by management agencies have included production of videos, brochures, and trinkets.

Loach minnow suffers from continuing invasion and colonization of habitats by nonnative predators. Several populations of loach minnow are on Indian reservations where information

on their status is either lacking or not available due to tribal restrictions. Habitat with potential for reestablishment of loach minnow continues to be lost due to lack of regulatory protection against such threats as groundwater pumping. Renewed interest in storage and diversion of water from the upper Gila River reopens a continuing threat to existence of the species in New Mexico.

Due to population losses and increased threats since the recovery plan was written, USFWS has found in a petition finding that uplisting of loach minnow to endangered status is warranted. USFWS (2004) reported that achievement of recovery objectives for loach minnow was 0-25%. We estimate that there has been a low to moderate achievement of recovery goals, but goals that are essential for on-the-ground improvement of conditions for loach minnow have not been initiated. A considerable amount of habitat protection from grazing and other land uses has been done and riparian area conditions have shown remarkable improvement. How loach minnow may respond to these altered conditions is unknown and is not being investigated except through monitoring. Establishment of loach minnow in Fossil Creek would restore the species to the Verde River system, from which it has been absent for longer than half a century. Dedication of selected stream systems to native fishes could increase the number of populations of loach minnow. However, with no emphasis by management agencies toward removing nonnative fishes from occupied habitats or restoring the species in other waters, it is virtually certain that recovery goals will not be met.

Table 9. Summary of status review findings for the loach minnow relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation

Task	Average subtask score
1. Protect existing populations of loach minnow.	1.7
2. Monitor status of existing populations.	1.7
3. Identify nature and significance of interaction with nonnative fishes.	1.1
4. Quantify, through research, loach minnow habitat needs and the effects of physical habitat modification on life cycle completion	0.9
5. Enhance or restore habitats occupied by depleted populations.	1.2
6. Reintroduce populations to selected streams within historic range.	1.6
7. Determine quantitative criteria for describing a self-sustaining population.	0.1
8. Plan and conduct investigations on captive holding, propagation and rearing.	2.0
9. Information and education.	1.4

Current Status in Gila River basin

Population in Aravaipa Creek apparently healthy and vigorous, although declining in lower end of range. Other populations declining.
USFWS (2004) reports status as declining.

Review of 5 Listing Factors

Factor	At time of listing (1986)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Loss or alteration of habitat due to impoundments, diversions, groundwater pumping, channel downcutting, channelization, riparian vegetation destruction, erosion, mining, grazing, and watershed disturbances, alteration of flow regimes and elimination of natural flooding patterns, alteration of water	Similar, but removal of grazing in some habitats has improved physical habitats. Water development threat on upper Gila River increasing. Increasing urbanization of watersheds and streambanks.

	temperatures, alteration of silt and bed loads, loss of marshes and backwaters, alteration of natural stream course characteristics. Planned dam construction on upper Gila River, water diversion on upper Verde River.	
2. Overutilization for commercial, sporting, scientific or educational purposes.	No threat identified.	
3. Disease or predation.	Introduction and spread of nonnative predatory fishes.	Introduction and spread of nonnative predatory and competitive fishes, crayfish, and pathogens rapidly increasing, introduction and spread of Asian tape worm.
4. Inadequacy of existing regulations.	State laws prohibit take, but do not provide protection of habitat; state water laws do not protect instream flows; state laws allow use of bait fish (e.g., red shiner) in occupied habitat.	Worse, no critical habitat protection. Lack of State laws protecting surface water from groundwater withdrawals.
5. Other natural or manmade factors affecting its continued existence.	Introduction and spread of red shiner combined with disturbance of natural flooding patterns	Worse. Extended drought adversely affecting most populations.

Razorback sucker

Xyrauchen texanus

Razorback sucker was listed as endangered in 1990. A recovery plan was approved in 1998, and recovery goals amended and supplemented in 2002 (USFWS 1991b, 1998b, 2002c). Critical habitat was designated in 1994 (USFWS 1994b). Recovery objectives were protection and expansion of three existing populations, and establishment of five new ones from remnant stocks or reintroductions, including one in the lower basin. The supplement provided quantitative criteria for recovery, and their relationship with the biological needs of the species was clearly defined. For delisting, establishment of two self-sustaining populations in the mainstem Colorado River and/or tributaries (which could include Gila River basin streams) maintained over a 5-year period was directed. Projected delisting could be proposed in 2023.

Historical range of razorback sucker in the Gila River basin included all of the Gila River to the Arizona-New Mexico border, and all major tributaries except for the Santa Cruz River. All Gila River basin wild populations are extirpated. Except for programs that stock fish into the Verde River main stem and monitoring of those stockings, there are no ongoing recovery actions for razorback sucker in the Gila River basin. Beginning in the early-1980's, hundreds of thousands of larval razorback suckers were stocked into the Salt and Verde rivers and tributaries. This effort was largely unsuccessful due to predation by nonnative fishes on the stocked individuals. Since 1991, individuals >300mm in length have been stocked into the Verde River. Due to concerns expressed by the White Mountain Apache Indian Tribe, only one stocking of razorback sucker has been made into the Salt River since the late 1980's. Recaptures of razorback

sucker in Verde River have been low, and in Salt River very low, and reproduction has not been documented.

The recovery plan identified four tasks with 57 subtasks, which included 18 priority 1, 21 priority 2, nine priority 3, four priority 4, and five priority 5 subtasks (Appendix: razorback sucker). Task 1 applied only to extant populations, none of which are in the Gila River basin. Nine (43%) of the priority 2 subtasks have been initiated and five (24%) completed (Table 10). All priority 3 subtasks have been initiated, and three (33%) completed. Two priority 4 subtasks (50%) were initiated, and all priority 5 subtasks have been initiated but not completed. The amendment provided five factors with 19 subtasks; priorities were not assigned. None of factors A and B have been initiated in the Gila River basin. One (17%) of six subtasks under factor C has been initiated, as has one (25%) of four subtasks under factor D, but none of factor E has been initiated. Subtask scores were likewise low.

Subtask scores for the both the recovery plan and supplemental goals reflect that little management activity has been done in the Gila River basin, except for a long-term but scaled-back and static stocking program (Task 2) that has not resulted in establishment of a self-sustaining population. Angling regulations have been promulgated for the Salt and Verde rivers in order to enhance survival of native fishes, and land management activities have been altered to avoid adverse modification of critical habitat (Task 3). Quantitative recovery goals (Task 4) were provided in the supplement, but ecosystems have not been restored in the Gila River basin. Subtasks identified in the supplement have not been initiated.

Threats to the razorback sucker remain the same as when the species was listed. Expanding urbanization of the Verde Valley and the Prescott area is causing increased pumping of groundwater. The rapid increase in the flathead catfish population in the Salt River has impacted the entire native fish assemblage there, and nonnative fish in the Verde River appear to be increasing in abundance.

Our assessment that achievement of recovery plan tasks has been low, and that of supplemental tasks has been very low agrees with the USFWS (2004) estimate of only 0-25% achievement of recovery objectives for razorback sucker range-wide. Recovery cannot be achieved without commitment from agencies to alter management strategies in potential habitats. Conversion of selected stream courses to native fish only or seasonal removal of nonnative fishes has potential to enhance conditions for razorback sucker. Fossil Creek has a history of providing “grow-out” conditions for razorback sucker, and should be considered for reestablishment. Construction of “grow-out” ponds along the Gila, Salt, and Verde rivers also holds promise. Recommendations to alter the stocking program in the Verde River have been made, but not implemented. Without commitment to reduce the abundance of nonnative fishes in the Salt and Verde rivers, it is unlikely that recovery goals will be met by the projected recovery date.

Table 10. Summary of status review findings for razorback sucker relative to recovery in the Gila River basin, current status, and review of listing factors. Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Recovery Plan Implementation	
Tasks from the recovery plan	Average subtask score
1. Prevent extinction of major extant razorback sucker populations and permanent loss of genetic diversity of existing populations.	N/A
2. Establish and protect additional wild populations.	1.1
3. Protect and maintain razorback sucker populations and their habitats.	1.4

4. Develop quantitative recovery goals and a long-term habitat protection strategy.	1.4
5. Promote and encourage improved communication and information dissemination.	1.2

Factors from the amendment and supplement	
A. Adequate habitat and range for recovered populations provided.	0.0
B. Protection from over utilization for commercial.	N/A
C. Adequate protection from diseases and predation.	0.2
D. Adequate existing regulatory mechanisms.	0.2
E. Other natural or manmade factors for which protection has been provided.	0.0

Current Status in Gila River basin

No wild populations exist, although stocking of subadults into Verde River continues.
Stocking into Gila and Salt rivers and tributaries discontinued.
USFWS (2004) reports range-wide status as uncertain.

Review of 5 Listing Factors

Factor	At time of listing (1992)	Current situation (2006)
1. Present or threatened destruction, modification, or curtailment of its habitat or range.	Habitat loss and alteration due to dams, diversions, groundwater pumping, water temperature alteration due to impoundments, alteration of flow regimes, planned and continuing construction of dams and reservoirs on several streams, transbasin diversions, loss of bottomland habitat due to diking and channelization.	Similar. Increasing groundwater pumping in Verde Basin threatens flows. Increasing urban and suburbanization is reducing floodplain recovery potential.
2. Overutilization for commercial, sporting, scientific or educational purposes.	Not considered a threat.	
3. Disease or predation.	No disease or pathogen threat. Predation on eggs, larvae, and young by nonnative fishes.	Introduction and spread of nonnative parasites and fishes, including Asian tapeworm and inland silverside.
4. Inadequacy of existing regulations.	State regulations protect species from take, but not habitat losses or spread of nonnative fishes, state water quality standards emphasize “clean” water, which may be detrimental to species.	Similar. Lack of State laws protecting surface water from groundwater withdrawals.
5. Other natural or manmade factors affecting its continued existence.	Continuing introduction and spread of nonnative species, reservoir habitats may not produce sufficient density of food items needed by larval razorback suckers, intercrossing between razorback sucker and flannelmouth sucker.	Similar. Extended drought exacerbating habitat loss and nonnative effects.

Conclusions

Tasks found in recovery plans for Gila River basin fishes were typically divided into four major categories: 1) protection, enhancement, and monitoring of extant populations and habitats, 2) reestablishment into historical habitats, 3) research, and 4) information and education. We found that tasks and subtasks identified in the recovery plans generally remained valid, and if effectively applied could make substantial contributions toward recovery of all species. A recovery plan for Gila chub needs to be developed, the redrafted plan for Gila topminnow needs approval, and those for desert pupfish, spikedace, woundfin, and loach minnow need to be reviewed. There is no compelling need at this time to do a complete revision of recovery plan tasks, although new biological information and understanding, cultural and political changes, and current USFWS guidance and policy[10] could lead to some modifications. Notwithstanding, implementation of recovery actions should not be further delayed by expenditure of scarce agency resources on rewriting or supplementing recovery plans. In the face of decades of relative inaction and continuing declines of the native fish assemblage, there is a critical need to aggressively implement existing plans for all listed fishes in the Gila River basin.

Protection and enhancement of extant populations and habitats as directed by recovery plans has failed to stem the decline of any of the listed fish. Most of the warm water Gila River basin fishes have been listed for many decades and have had approved recovery plans for similar periods of time, but nearly all are declining in range and abundance. USFWS (2004) reported that the range-wide population status of spikedace, woundfin, Gila topminnow, and loach minnow was declining, bonytail and razorback sucker was uncertain, desert pupfish was stable (in California), and Colorado pikeminnow was increasing (in the upper Colorado River basin)[11]. Extant populations are not being protected sufficiently to avoid loss from occupied habitats, and potential recovery habitats are being precluded due to invasion from nonnative fishes. The main cause of ongoing decline for most of these species is the presence of nonnative fishes, and there have been only a few efforts to remove nonnative species from occupied habitats. A few barriers have been constructed to protect native assemblages from invasion by nonnative species, and renovations have removed nonnative species from several streams. Monitoring has documented the decline and demise of native assemblages and the increasing presence of nonnative species.

Reestablishment into historical habitats in the Gila River basin is ongoing for desert pupfish, Gila chub, Gila topminnow, Colorado pikeminnow, and razorback sucker, but amount of activity is light. During the past two decades, five sites were stocked with desert pupfish, and 22 with Gila topminnow. Gila chub was reestablished in Turkey Creek. Colorado pikeminnow and razorback sucker have been stocked into the Verde River, but continued presence of nonnative fish negates those efforts and there have been no adaptive changes in many years. The other species (bonytail, spikedace, woundfin, and loach minnow) have no reestablishment programs, although hatchery propagation techniques have been developed and sufficient stocks could be produced to support reestablishment programs.

Research tasks direct field and laboratory study of all aspects of life history, biology, genetics, habitat parameters, species responses to environmental conditions and perturbations, development of quantifiable recovery goals, and early detection of debilitating parasites and

[10] Recovery plans for bonytail, Colorado squawfish, razorback sucker, and humpback chub *Gila cypha* were supplemented in 2002 to meet requirements of Section 4(f)(1)(B) of the ESA. Recently, District Court in Arizona ordered USFWS to withdraw the 2002 recovery goals for humpback chub because time and cost estimates were not provided as required. Status of the other three plans, which have similar language, is unclear at this time.

[11] Gila chub had not been listed at time of report.

diseases. Notably, most discuss the need for determining the role of predation and competition from nonnative species. Research probably has the highest percentage of completed subtasks of any of the four major categories, primarily due to the fact that conducting and funding research is an ongoing and integral function of academia and management agencies, there is a large pool of scientists, biologists, and students available to conduct the tasks, and it seldom involves on-the-ground activities that may be controversial.

One aspect of research that has been administratively controversial revolves around the use of genetics investigations to differentiate stocks of fish. USFWS developed a regional policy that states that any subdivisions (subspecies, populations, and stocks) less than the listed entity cannot be considered for down- or de-listing criteria. For a listed species, recovery criteria can only apply to the species as a whole, and not to any subspecies, population, or stock. This policy may permit loss of genetic stocks that are distinctly unique, so long as one stock of each species still exists and can be used to replace the others. However, the policy does allow the consideration of genetic information in recovery planning. Subdivisions of the listed entity, be they genetically based or otherwise separated, can be considered in a recovery plan as management guidance, as long as it is not part of the criteria for down- or de-listing. This regional policy has received strong national criticism as being ignorant of the need to maintain genetic diversity in endangered species management and recovery. Revision of Gila topminnow down- and delisting criteria to meet this policy is underway, as is planning to modify the desert pupfish recovery plan with revised down- and delisting criteria to conform to the new policy.

Information and education is a category that should have a much higher level of completion. But native fish in the Gila River basin get very little publicity from management agencies, whereas nonnative fisheries receive considerable attention. A few videos that discuss native southwestern fishes in general are available, as are a variety of glossy brochures and trinkets. The most useful tool for disseminating information, the internet, is virtually unused for endangered species in general, and Gila River basin fishes in particular. A notable exception is the website for the USFWS (http://www.fws.gov/endangered/) where information about all federally-listed species is easily retrievable. Neither Arizona nor New Mexico state wildlife departments, agencies with the strongest charge for information and education on native fishes, have websites that provide easily accessible and usable information. Moreover, little or none of the native fish content at these sites has benefited from expert review and thus may contain misleading or erroneous information, and the information in many cases is sorely dated. Websites for other state and federal agencies with management responsibilities for native fish have minimal to no information about endangered species, and for those with information, it is usually difficult to find, lacking in detail, and often misleading or inaccurate.

USFWS (2004) assessed that only 0-25% of recovery objectives had been achieved for the species considered in this report, except for Colorado pikeminnow (51-75%, in upper Colorado River basin). We estimated that desert pupfish, bonytail, woundfin, Colorado pikeminnow, and razorback sucker had minimal or low achievement of recovery objectives, and spikedace, Gila topminnow, and loach minnow had low to moderate achievement. Conservation and recovery efforts described in the recovery plans have been limited in their extent and degree of implementation. Very few subtasks have been accomplished fully, although many have been initiated. For those where implementation has occurred, success has been low. In general, implementation of research has been strong, but management actions to protect and increase populations have been meager, and monitoring has been desultory and applied to only a few populations. Information and education efforts for Gila River basin fishes are nominal.

It is absolutely vital that the issue of nonnative fishes be addressed if recovery goals are to be achieved. Without sanctuary from nonnative fishes, the native fish assemblages will continue to decline and disappear. Since the recovery plans were written, the Salt River has been dropped from the stocking program for razorback sucker and Colorado pikeminnow due to a sudden increase of flathead catfish and opposition from tribal interests. Verde River is experiencing increased presence and range of nonnative fishes, which is affecting the stocking success of the above two native species as well as lowering the number of spikedace to the point that they have not been detected for several years. Middle Fork Gila River in New Mexico is now populated with a suite of nonnative fishes and the native fishes present are generally adults of the large-bodied species. The mainstem Gila River in New Mexico and eastern Arizona is dominated by assemblages of nonnative species, mostly bullhead catfishes (family Ictaluridae). Populations of Gila topminnow continue to "wink out" as western mosquitofish invade (e.g., Sharp Spring, Redrock Canyon), and most reintroduction efforts are stalled due to local opposition from ranchers and management agencies. Recent surveys have failed to find Gila chub in San Pedro River habitats in Sonora.

Without control of nonnative fishes, it is highly likely that other native species will become candidates for listing. Headwater chub *Gila nigra* has been found warranted for listing primarily due to threats from nonnative species, although a proposal for its listing may be delayed for many years due to other priorities and inadequate funding. Roundtail chub *G. robusta* is suffering a similar crisis, but its presumed healthy status in the upper Colorado River basin precluded it from being considered for listing as a distinct population segment in the lower Colorado River basin, despite significant genetic, biological, and ecological differences. Increasingly, however, establishment of nonnative fishes are thwarting recovery efforts for native fishes even in the upper basin.

> *It appears the No. 1 threat to our native wildlife and fish in these imperiled biotic communities continues to be the introduction, perpetuation and expansion of non-native sport fish, baitfish, crayfish and bullfrogs throughout Arizona's river systems. This primary threat remains the "800-pound gorilla in the room" that nobody wants to talk about.*
>
> *While angling is an important American pastime, we need to urge wildlife decision-makers to get serious and take aggressive actions now, on behalf of the general public, to designate larger rivers as "wholly native" before it's too late for our quickly vanishing native species.*
>
> Letter to the editor, Arizona Republic, 8/20/2006

At one time longfin dace *Agosia chrysogaster*, speckled dace *Rhinichthys osculus*, flannelmouth sucker *Catostomus latipinnis*, desert sucker *Pantosteus clarki*, and Sonora sucker *Catostomus insignis* were on the USFWS candidate species list, chiefly because nonnative fishes were overwhelming their habitats. Flannelmouth sucker was lost from the Gila River basin decades ago, partially a result of nonnative fish invasion. It is now part of an interstate, multispecies agreement aimed at preventing its further decline elsewhere in the basin. All native species are being replaced by nonnatives in the mainstem Gila River in Arizona and into New Mexico. Desert sucker is disappearing from the San Pedro River. Populations of longfin dace and speckled dace are depressed in upper Verde River due to nonnative fish. Many other streams are suffering similar scenarios.

The story of the Gila River basin native warm water fishes is mainly one of the past, and the history of efforts to slow or reverse their decline is one of primarily neglect. What is needed is a renewed commitment to conservation of endangered fishes in the Gila River basin. Their plight has been known for decades, but the extent of activities implemented for their benefit has been minimal at best. The leadership of management agencies, when not actively resisting recovery efforts for these fish, has taken a "benign neglect" approach to their management; that is, ignore

the problem with a cheerful sanguinity that it eventually will go away. Instead of directing active management, decision makers have indulged in proleptic rhetoric, or given emphasis to public information and education (e.g., videos, posters, glossy brochures, trinkets). Such activities are colorable, and they have diverted attention from higher priority on-the-ground efforts that must happen to stabilize populations, increase abundance and range, and prevent extirpations and eventual extinctions. Biologists and technicians concerned with native fishes spend most of their time doing paperwork (e.g., NEPA documentation, Section 7 consultation, planning, and report writing and reviewing) or attending meetings, and have little time available for project development. They do, however, continue to propose on-the-ground actions for the betterment of the species, but their recommendations are ignored, sidelined, unfunded, or otherwise unsupported.

For instance, there are numerous proposals for projects to benefit native fishes that have been in existence for 5 to 20 years with no accomplishment to date. Recovery plans for desert pupfish, spikedace, and loach minnow recommended reintroductions into the San Pedro River, a task that was reiterated in the 1993 habitat management plan for the San Pedro River Riparian National Conservation Area. The Gila topminnow recovery plan recommended removal of western mosquitofish from Redrock Canyon. A project to establish spikedace in Redfield Canyon was recommended in the recovery plan for that species. None of these projects have been implemented, although Redfield Canyon has been in planning for at least 5 years, and Redrock Canyon is currently in planning. A simple project to deepen and increase storage capacity in a stock tank to benefit Gila topminnow took longer than 6 years in planning and negotiations to accomplish. Multiple recommendations to renovate Bog Hole Tank and restock with native pupfish and other species were made during the past 20 years, but never acted upon. Perhaps most frustrating is that all the technical tools needed to implement and attain recovery are in hand, but severely limited resources, burgeoning non-biological constraints, and lack of positive leadership have dictated inaction for most species. We conclude that implementation and accomplishment of recovery tasks for fishes in the Gila River basin has been woefully inadequate, and the prognosis for recovery of any Gila River basin warm water fish in the foreseeable future is bleak.

Notwithstanding, a few bright spots in this otherwise gloomy scenario exist. Removal of nonnative fishes has a proven success record in invigorating native fish populations. Gila chub in Sabino Canyon experienced large population growth after nonnative fishes were removed. The native fish assemblage in Fossil Creek rebounded after chemical renovation to remove nonnative species. Longfin dace and Gila topminnow reappeared in O'Donnell Creek after nonnatives were removed. Lands have been purchased for protection of Gila topminnow and other aquatic species. Both Arizona and New Mexico Game and Fish commissions have promulgated several regulations to benefit native fish. Successful projects, such as stockings of Gila topminnow, desert pupfish, and Gila chub, barrier construction on Aravaipa and Fossil creeks and Cottonwood Spring, and the renovations mentioned above demonstrate clearly that recovery actions can be undertaken and are supported by the public. Fossil Creek, for example, is being touted nationally as an example of ecosystem restoration that was accomplished via a cooperative effort that included multiple agencies, a tribal government, nongovernmental organizations, and a publicly-held corporation. These successes need to be built upon and emphasized, because they can represent the future for native fish in the Gila River basin.

Appendix

The recovery goals and related information in this appendix were copied verbatim from each recovery plan. Tasks and subtasks were taken from each recovery plan but sometimes paraphrased in the interest of space reduction. Each table includes tasks and subtasks, and their priority as listed in the recovery plans. Additionally, accomplishments for each task that are pertinent to the Gila River basin are described, as are our assessments of whether the task has been initiated and/or completed. Subtask scores are the team's estimate of the level of implementation on a 5-tier (0 to 4) scale[12] (see Williams et al. 2005).

Desert pupfish

Cyprinodon macularius

Recovery Criteria *(USFWS 1993)**: Secure, maintain, and replicate all naturally occurring extant populations. Re-establish replicate populations in the most natural, identifiable habitats within the probable historical range. Each replicated population will not be considered established until the population has persisted for a minimum of ten years. Protection and establishment of refugium populations of Quitobaquito and Rio Sonoyta forms.*

Actions Needed (Table 11)***:***

1. *Protect natural populations and their habitats.*
2. *Re-establish populations.*
3. *Establish a refugium population of Quitobaquito pupfish.*
4. *Develop protocol for exchange of genetic material.*
5. *Monitor natural and replicated populations.*
6. *Determine factors affecting population persistence.*
7. *Information and education.*

Date of Down listing: *Down listing is expected to occur in 2009 for the subspecies C. macularius macularius, if down listing criteria are met (USFWS 1993).*

Table 11. Tasks identified in recovery plan for desert pupfish *Cyprinodon macularius* and accomplishments of tasks within the Gila River basin. (For explanation of task score entries, see Methods in text).

Desert pupfish Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1. Protect natural populations of desert pupfish					
1.1 Identify ownership of extant populations and natural habitats	1	No natural populations remain in Gila basin.	N/A	N/A	N/A

[12] Task scores: 0 = no or minimal implementation, 1 = low implementation, 2 = moderate implementation, 3 = high implementation, 4 = complete or near-complete implementation, N/A = not applicable to Gila River basin.

Desert pupfish Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.2 Acquire habitats occupied by natural populations of desert pupfish	1	Not applicable	N/A	N/A	N/A
1.3 Secure natural populations and their habitats	1	Not applicable	N/A	N/A	N/A
2. Re-establish desert pupfish populations					
Reestablish populations (10 tier 2[13], 45 tier 3)	2	Tier 2 populations: Lousy and Larry canyons (2001), Tier 3 populations: Cold Springs Seep (1990); Parsons Canyon, Bleak Spring, and Cement Tank (2005).	Yes	No	1.0
3. Establish a refugium population of Quitobaquito pupfish					
Establish Quitobaquito refugia	2	Not applicable to Gila basin (refuge developed at Organ Pipe Cactus National Monument visitor center and Cabeza Prieta National Wildlife Refuge headquarters)	N/A	N/A	N/A
4. Develop protocols for exchange of genetic material among desert pupfish populations					
Genetic exchange protocol	1	A 1998 FWS-contracted study recommended steps for a genetic protocol. That has apparently never been adopted or implemented. Refugium populations re-sampled in 2005 for genetics assessment by A. Echelle. Task requires multiple populations for accomplishment.	Yes	No	0.8
5. Monitor and maintain natural, re-established, and refugium populations					

[13] Population tiers are defined in the desert pupfish recovery plan. Tier 1 is comprised of extant, naturally occurring populations; none of which remain in Arizona or the Gila River basin. Tier 2 populations are replicates of naturally occurring stocks re-established into habitats more nearly representing historical conditions, and Tier 3 represents another suite of re-established populations that may be placed into quasi-natural habitats. The Recovery Plan provides general guidance for genetic exchange among tiers but does not specify a protocol. Tier 2 and 3 populations must persist for at least 10 years to be counted toward recovery, and other criteria also apply. The many stockings into school yard ponds and other similar habitats do not count towards the recovery criteria in the Recovery Plan.

Desert pupfish Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
Monitor and maintain populations	1	Monitoring of reestablished populations is being done, but does not meet recovery criteria (twice annual assessment of population and habitat, and 5-year genetic assessment). Genetic assessments of varying types were conducted in 1998 and 2005. Captive populations in existence.	Yes	No	1.7
6. Determine factors affecting population persistence					
6.1 Develop habitat criteria	2	No agency has contracted for, developed, or adopted habitat criteria.	Yes	No	0.4
6.2 Determine biological criteria	2	No agency has contracted for, developed, or adopted biological criteria in Gila River basin. Study of biological factors conducted in Salton Sea, CA area in recent years.	No	No	0.0
6.3 Acquire desert pupfish life history information	3	Life history information available (acquired on populations outside of Gila River basin).	Yes	No	0.0
7. Information and education					
Information and education	3	Video produced. Brochures and trinkets available. Numerous school ponds stocked with pupfish in Gila River basin.	Yes	No	1.5

Bonytail

Gila elegans

*The **recovery goal** (USFWS 1990) in the short-term is to prevent extinction of the bonytail chub. In the long-term, once the immediate threat of extinction is removed, quantitative goals for down listing and delisting will be addressed. Recovery criteria will be developed after completion of various recovery actions.*

*The **major actions*** (Table 12) *needed to secure the survival of the bonytail chub are:*

1. *Prevent extinction of the bonytail chub by establishing a genetically diverse captive population for use in efforts to reintroduce the fish into the wild.*
2. *Obtain essential information on the life history and habitat requirements of the bonytail chub.*

3. Resolve taxonomic problems in Colorado River basin chubs; the bonytail, humpback, and roundtail.
4. Develop quantitative recovery goals and a long-term habitat protection strategy.

The goal of the Recovery Program is to recover the Colorado River fishes in the Upper Colorado River Basin, excluding the San Juan River, by the year 2003 at an estimated cost of $59 million. …Development of a similar program for the Lower Colorado River Basin is being planned. An estimated recovery cost and recovery date will be established for the Lower Basin during the development of this program (USFWS 1990).

Recovery Objective: *Down listing and Delisting (USFWS 2002a).*

Recovery Criteria: *Objective, measurable criteria for recovery of bonytail in the Colorado River Basin are presented for each of two recovery units (i.e., the upper basin, including the Green River and upper Colorado River sub basins; and the lower basin, including the main stem and its tributaries from Lake Mead downstream to the southerly International Boundary with Mexico) because of different recovery or conservation programs and to address unique threats and site-specific management actions/tasks necessary to minimize or remove those threats. Recovery of the species is considered necessary in both the upper and lower basins because of the present status of populations and existing information on bonytail biology. Self-sustaining populations will need to be established through augmentation. Without viable wild populations, there are many uncertainties associated with recovery of bonytail. The bonytail was listed prior to the 1996 distinct population segment (DPS) policy, and the U.S. Fish and Wildlife Service (Service) may conduct an evaluation to designate DPSs in a future rule-making process. These recovery goals are based on the best available scientific information, and are structured to attain a balance between reasonably achievable criteria and ensuring the viability of the species beyond delisting. These recovery criteria will need to be reevaluated and revised after self-sustaining populations are established and there is improved understanding of bonytail biology.*

Down listing *can occur if, over a 5-year period: (1) genetically and demographically viable, self-sustaining populations are maintained in the Green River sub basin and upper Colorado River sub basin such that — (a) the trend in adult (age 4+; 250 mm total length) point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 (150–249 mm TL) naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 4,400 adults (4,400 is the estimated minimum viable population [MVP] needed to ensure long-term genetic and demographic viability); and (2) a genetic refuge is maintained in a suitable location (e.g., Lake Mohave, Lake Havasu) in the lower basin recovery unit; and (3) two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit (e.g., main stem and/or tributaries) such that — (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 4,400 adults; and (4) when certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.*

Delisting *can occur if, over a 3-year period beyond down listing: (1) genetically and demographically viable, self-sustaining populations are maintained in the Green River sub basin and upper Colorado River sub basin such that — (a) the trend in adult point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-*

3 naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 4,400 adults; and (2) a genetic refuge is maintained in the lower basin recovery unit; and (3) two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit such that — (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 4,400 adults; and (4) when certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.

Conservation plans will go into effect at delisting to provide for long-term management and protection of the species, and to provide reasonable assurances that recovered bonytail populations will be maintained without the need for relisting. Elements of those plans could include (but are not limited to) provision of flows for maintenance of habitat conditions required for all life stages, regulation and/or control of nonnative fishes, minimization of the risk of hazardous-materials spills, and monitoring of populations and habitats. Signed agreements ix among State agencies, Federal agencies, American Indian tribes, and other interested parties must be in place to implement the conservation plans before delisting can occur.

Management Actions Needed:

1. Reestablish populations with hatchery-produced fish.
2. Identify genetic variability of bonytail and maintain a genetic refuge in a suitable location in the lower basin.
3. Provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations.
4. Provide passage over barriers within occupied habitat to allow unimpeded movement and, potentially, range expansion.
5. Investigate options for providing appropriate water temperatures in the Gunnison River.
6. Minimize entrainment of sub adults and adults at diversion/out-take structures.
7. Investigate habitat requirements for all life stages and provide those habitats.
8. Ensure adequate protection from over utilization.
9. Ensure adequate protection from diseases and parasites.
10. Regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries.
11. Control problematic nonnative fishes as needed.
12. Minimize the risk of increased hybridization among Gila spp.
13. Minimize the risk of hazardous-materials spills in critical habitat.
14. Remediate water-quality problems.
15. Provide for the long-term management and protection of populations and their habitats beyond delisting (i.e., conservation plans).

Estimated Time to Achieve Recovery: *Wild bonytail are rare. Therefore, use of hatchery fish (progeny of cultured brood stock) will be necessary to establish new populations. Time to achieve recovery of the bonytail cannot be accurately estimated until self-sustaining populations are established through augmentation and habitat enhancement. The rate at which populations become established will depend on survival of stocked fish in the wild, integration of stocked fish with rare wild stocks, reproductive success, and recruitment. Response of the species to ongoing management activities will need to be assessed through monitoring, and strategies for*

recovery and estimates of time to achieve recovery will be reevaluated periodically. Based on current information and associated uncertainties, it is estimated that self-sustaining populations of bonytail will become established over the next 15 years. During this time, population dynamics and responses to management actions will be evaluated. For bonytail populations to be self-sustaining, adults must reproduce and recruitment of young fish into the adult population must occur at a rate to maintain the population at a minimum of 4,400 adults. When this occurs, the definition of a "self-sustaining" population is met, and the "clock" starts on the down listing and delisting process. Once self-sustaining populations have been established, reliable population estimates, based on a multiple mark-recapture model, are needed for all populations over a 5-year monitoring period for down listing and over a 3-year monitoring period beyond down listing in order to achieve delisting. The accuracy and precision of each point estimate will be assessed by the Service in cooperation with the respective recovery or conservation programs, and in consultation with investigators conducting the point estimates and with qualified statisticians and population ecologists. Self-sustaining populations and first reliable point estimates for all populations are expected by 2015. If those estimates are acceptable to the Service and all recovery criteria are met, down listing could be proposed in 2020 and delisting could be proposed in 2023 (USFWS 2002a).

Table 12a. Tasks identified in recovery plan for bonytail *Gila elegans* and accomplishments of tasks within the Gila River basin. Priorities were not given.

Bonytail **Task**	**Accomplishments**	**Task initiated**	**Task completed**	**Subtask score**
Task 1. Prevent extinction of bonytail chub in the wild.				
11. Protect in refugia.				
111. Establish and maintain refugia in at least two locations.	-Gila R. Indian Res. grow-out ponds for Lake Havasu (project abandoned). -Bubbling Ponds State Hatchery (No bonytail on site).	N/A	N/A	
112. Evaluate genetics of captive bonytail chub.	Genetics of captive bonytail evaluated at ASU.	N/A	N/A	
113. Obtain wild bonytail chub.	Species extirpated from Gila River basin.	N/A	N/A	
114. Verify taxonomic status of individuals received at refugia.	Verified.	N/A	N/A	
12. Protect populations of bonytail chub and their habitats.				
121. Enforce established regulations to minimize threats.				
1211. Inform appropriate agencies of their management and enforcement obligations.		N/A	N/A	
1212. Ensure compliance with Section 7 of the Endangered Species Act by Federal agencies.		N/A	N/A	

Bonytail Task	Accomplishments	Task initiated	Task completed	Subtask score
122. Develop and implement cooperative interagency programs to protect and recover the bonytail chub.	AZGFD established Native Fish Conservation Team in 2003, but has not addressed bonytail chub.	N/A	N/A	
123. Prohibit the further introduction of nonnative fishes into the Colorado River system.	Special regulations prohibiting introduction of nonnative fishes in Gila River basin. Restrictions on use of live fish in portions of Gila River basin.	N/A	N/A	
124. Protect high priority recovery areas.	None identified in Gila River basin.	N/A	N/A	
13. Reintroduce hatchery-reared bonytail chub into the wild.				
131. Develop and implement an artificial propagation and rearing plan.				
1311. Assess and refine propagation techniques to maximize survival in wild.	Long term programs in place at federal facilities, but none directed at, or in Gila River basin.	N/A	N/A	
1312. Maximize genetic diversity.		N/A	N/A	
1313. Rear bonytail chub to a size that promotes good post-stocking survival.		N/A	N/A	
132. Conduct experimental stocking of bonytail chub and identify priority recovery sites.	Not done in Gila River basin.	N/A	N/A	
133. Stock bonytail chub in priority recovery sites.		N/A	N/A	
Task 2. Obtain essential information on the life history and habitat requirements of the bonytail chub.				
21. Describe spawning requirements.		N/A	N/A	
22. Determine role of predation/competition.		N/A	N/A	
23. Describe movement patterns.	No individuals present in Gila River basin.	N/A	N/A	
24. Identify and describe essential habitat.		N/A	N/A	
25. Describe food habits and feeding behavior.		N/A	N/A	
26. Evaluate aging techniques.		N/A	N/A	

Bonytail Task	Accomplishments	Task initiated	Task completed	Subtask score
27. Describe age distribution and growth rates.		N/A	N/A	
28. Determine reasons for and significance of hybridization.		N/A	N/A	
Task 3. Resolve taxonomic problems in Colorado River basin *Gila.*		N/A	N/A	
Task 4. Promote and encourage improved communication and information dissemination.				
41. Develop an information and education program to inform the public of the bonytail chub's status and uniqueness.	Brochures and trinkets put out by AZGFD.	N/A	N/A	
42. Encourage and support publication of research and other recovery results in the technical literature.	No research in Gila River basin.	N/A	N/A	
43. Develop and conduct workshops to coordinate recovery efforts.	Not in Gila River basin.	N/A	N/A	
Task 5. Develop quantitative recovery goals and a long-term habitat protection strategy.	Recovery goals delineated in supplement to recovery plan.	N/A	N/A	

Table 12b. Lower basin site-specific management actions and tasks by recovery factor listed in supplement to recovery plan for bonytail *Gila elegans* and accomplishments of tasks within the Gila River basin. Priorities were not given.

Bonytail (supplement) Task	Accomplishments	Task initiated	Task completed	Subtask score
Factor A. Adequate habitat and range for recovered populations provided.				
A-1. Provide flows necessary for all life stages of bonytail to support recovered populations, based on demographic criteria.				
A-1.1. Identify, implement, evaluate, and revise (as necessary through adaptive management) flow regimes that are necessary for the establishment and maintenance of bonytail populations in the main stem and/or tributaries.		No	No	0.0
A-1.2. Provide flow regimes (as determined under Task A-1.1) that are necessary for all life stages of bonytail to support recovered populations in the main stem and/or tributaries.		No	No	0.0
A-2. Minimize entrainment of sub adult and adult bonytail in diversion/out-take structures.				
A-2.1. Identify measures (e.g., screens, baffles) to minimize entrainment of sub adult and adult bonytail at problematic diversion and/or out-take structures (see section 4.1 for discussion on entrainment).		No	No	0.0

Bonytail (supplement) Task	Accomplishments	Task initiated	Task completed	Subtask score
A-2.2. Install devices and/or implement other measures (as determined under Task A-2.1) to minimize entrainment.		No	No	0.0
A-3. Investigate habitat requirements for all life stages of bonytail (including importance of floodplain habitats) and provide those habitats necessary to support recovered populations, based on demographic criteria.				
A-3.1. Identify habitats that are necessary for the establishment and maintenance of bonytail populations in the main stem and/or tributaries.		No	No	0.0
A-3.2. Provide habitats (as determined under A-3.1) for all life stages of bonytail that are necessary to support recovered populations in the main stem and/or tributaries.		No	No	0.0
Factor B. Protection from over utilization for commercial.				
B-1 Protect bonytail populations from over utilization for commercial, recreational, scientific, or educational purposes.				
B-1.1. Reevaluate and, if necessary, identify actions to ensure adequate protection from over utilization of bonytail for commercial, recreational, scientific, or educational purposes; not currently identified as an existing threat.		N/A	N/A	
B-1.2. Implement identified actions (as determined under Task B-1.1) to ensure adequate protection of bonytail from over utilization for commercial, recreational, scientific, or educational purposes.		N/A	N/A	
Factor C. Adequate protection from diseases and predation.				
C-1. Minimize adverse effects of diseases and parasites on bonytail populations.				
C-1.1. Reevaluate and, if necessary, identify actions to minimize adverse effects of diseases and parasites on bonytail populations; not currently identified as an existing threat.		No	No	0.0
C-1.2. Implement identified actions (as determined under Task C-1.1) to ensure adequate protection of bonytail populations from deleterious diseases and parasites.		No	No	0.0
C-2. Regulate nonnative fish releases and escapement into the main stem, floodplain, and tributaries.				
C-2-1. Develop, implement, evaluate, and revise (as necessary through adaptive management) procedures for stocking and to minimize escapement of nonnative fish species into the main stem, floodplain, and tributaries to minimize negative interactions between nonnative fishes and bonytail.		No	No	0.0

Bonytail (supplement) Task	Accomplishments	Task initiated	Task completed	Subtask score
C-2.2. Finalize and implement procedures (as determined under Task C-2.1) for stocking and to minimize escapement of nonnative fish species 40 into the main stem, floodplain, and tributaries to minimize negative interaction between nonnative fishes and bonytail.		No	No	0.0
C.3. Control problematic nonnative fishes as needed.				
C-3.1. Develop control programs for problematic nonnative fishes in the main stem, floodplain, and tributaries to identify levels of control that will minimize negative interactions between nonnative fishes and bonytail.		No	No	0.0
C-3.2. Implement identified levels (as determined under Task C-3.1) of nonnative fish control in the main stem, floodplain, and tributaries.		No	No	0.0
Factor D. Adequate existing regulatory mechanisms.				
D-1. Legally protect habitat (see definition of habitat in section 5.1.2) necessary to provide adequate habitat and sufficient range for all life stages of bonytail to support recovered populations, based on demographic criteria.				
D-1.1. Determine mechanisms for legal protection of habitat through instream-flow rights, contracts, agreements, or other means.		No	No	0.0
D-1.2. Implement mechanisms for legal protection of habitat (as determined under Task D-1.1) that are necessary to provide adequate habitat and sufficient range for all life stages of bonytail to support recovered populations.		No	No	0.0
D-2. Provide for the long-term management and protection of bonytail populations and their habitats.				
D-2.1. Identify elements needed for the development of conservation plans that are necessary to provide for the long-term management and protection of bonytail populations; elements of these plans may include (but are not limited to) maintenance of genetic diversity in Lakes Mohave or Havasu, provision of flows for maintenance of adequate habitat conditions for all life stages of bonytail, regulation and/or control of nonnative fishes, and monitoring of populations and habitats.		No	No	0.0
D-2.2. Develop and implement conservation plans and execute agreements among State agencies, Federal agencies, American Indian tribes, and other interested parties to provide reasonable assurances that conditions needed for recovered bonytail populations will be maintained.		No	No	0.0

Bonytail (supplement) Task	Accomplishments	Task initiated	Task completed	Subtask score
Factor E. Other natural or manmade factors for which protection has been Provided				
E-1. Minimize the threat of hybridization among *Gila* species in river reaches occupied by bonytail.				
E-1. Evaluate and, if necessary, identify actions to minimize the risk of hybridization to bonytail; not currently identified as an existing threat.		N/A	N/A	
E-2. Implement identified action (as determined under task E-1) to ensure adequate protection of bonytail populations from hybridization.		N/A	N/A	

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Gila chub
Gila intermedia

A recovery plan for Gila chub has not been written.

Spikedace
Meda fulgida

Recovery Objective *(USFWS 1991d)**: Protection of existing populations, restoration of populations in portions of historic habitat, and eventual delisting, if possible.*

Recovery Criteria: This plan sets forth mechanisms to obtain information necessary to determine quantitative criteria for describing a spikedace population capable of sustaining itself in perpetuity. Delisting is dependent upon establishment of such populations.

Actions needed (Table 13)***:***

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

Date of Recovery: *Until work is completed to allow quantification of delisting criteria, it is not possible to predict a date of recovery. However, based on the evaluation period of 10 years for determination of success of reintroduced populations, recovery of this species could not occur in less than 20 years (USFWS 1991d).*

Table 13. Tasks and priorities identified in recovery plan for spikedace *Meda fulgida* and

accomplishments of tasks within the Gila River basin.

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1. Protect existing populations of spikedace.					
1.1. Identify extent of existing populations and level of protection afforded to each.	1	Indian reservations lack surveys. Other populations monitored.	Yes	No	3.0
1.2. Prioritize existing populations as to need or imminent need for protection.	2	All need protection.	Yes	Yes	3.5
1.3. Designate critical habitat.	1	Designated twice, first invalidated in court, second rescinded by USFWS. Reproposed December 2005.	Yes	No	1.5
1.4 Enforce existing laws and regulations affecting spikedace.					
1.4.1. Inform as necessary appropriate agencies of applicable management/enforcement responsibilities.	1	Ongoing	Yes	No	2.7
1.4.2. Assure compliance with Section 7 of the Endangered Species Act.	1	FWS policy changes favor programmatic approaches. In general, section 7 compliance decreasing due to policy shift away from regulation to voluntary compliance.	Yes	No	2.2
1.4.3. Assure compliance with Section 9 of the Endangered Species Act	1	Ongoing recovery permit administration delegated to State. No HCPs or prosecution of direct or incidental take of spikedace, despite identification of take during non-section 7 land and water modifications.	Yes	No	2.2
1.5. Discourage detrimental land and water use practices	1	Occurring only incidental to section 7 and other regulatory application. Livestock grazing curtailed.	Yes	No	1.7

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.6. Insure perennial flows with natural hydrographs	1	Aravaipa Creek has instream flow right, USFS applications pending for Verde River and Fossil Creek. Legislation introduced to give Fossil Creek "Wild and Scenic River" designation.	Yes	No	1.5
1.7. Curtail transport and introduction of nonnative fishes.	1	CAP program for management against nonnative aquatics; Fossil Creek renovation; open bag limits on nonnative sport fish in spikedace habitats in AZ. Uncertainty and delay of State decision to manage Verde River for native fish or to manage it for nonnative sport fishing. Introduction and spread of nonnatives continues to increase.	Yes	No	1.2
1.7.1. Discourage seining and use of live bait in streams occupied by spikedace	1	Special regulations promulgated by AZGF & NMGF commissions re: use of bait fish.	Yes	No	1.5
1.8. Examine efficacy of barrier construction to preclude invasion by nonnative fishes	1	Aravaipa Creek barriers; Central Arizona Project (CAP) nonnative & recovery program 2005 report on barrier efficacy.	Yes	Yes	2.8
1.9. Identify important, available private lands and water rights not already protected.	2	Lists of lands and water rights have been started.	Yes	No	1.3
1.10. Acquire important lands and associated water rights as they become available.	2	Some acquisition of lands as Federal infill or by TNC and State G&F.	Yes	No	1.2
1.11. Protect acquired lands.	2	Trespass grazing having negative impacts on upper Verde.	Yes	No	1.2
2. Monitor status of existing populations.					
2.1. Establish and implement standard monitoring locations for extant populations.	1	No programmatic aspect, no standardized monitoring protocol identified	Yes	No	2.3

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
2.2. Establish and implement standard techniques and their application.	1	Individual streams and/or personnel have standard techniques, but no overall range-wide standard techniques applied.	Yes	No	2.2
2.3. Establish and maintain a computerized database for tracking of monitoring and reintroduction information.	2	No centralized data base, but databases for individual populations maintained by researchers.	No	No	0.0
2.4. Determine range of natural variation in absolute abundance and age-class structure.	1		Yes	No	1.6
2.4.1. Develop standard methods for quantifying abundance.	1		No	No	0.0
2.4.2. Conduct bi-annual (spring, autumn) population estimates.	1	Bi-annual sampling only at Aravaipa Creek. No population estimates projected.	No	No	0.0
2.5. Monitor community composition.	1	During ongoing monitoring.	Yes	No	2.8
2.5.1. Apply standard locations and techniques (2.1, 2.2).	1		Yes	No	2.4
2.5.2. Determine range of natural variation in relative abundances of community members.	1	Long term data sets in Aravaipa Creek, and San Francisco, Tularosa, Gila River forks, and mainstem in NM analyzed.	Yes	No	2.0
2.6. Determine genetic characteristics of existing populations.	1	ASU studies.	Yes	Yes	4.0
3. Identify nature and significance of interaction with nonnative fishes.					
3.1. Direct interaction (predation, displacement).	2	Studies at various universities.	Yes	No	2.4
3.1.1. Field investigations and experimental manipulations.	2		No	No	0.0
3.1.2. Laboratory studies.	2		Yes	No	1.4

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
3.2. Indirect interaction (mediated by other fishes of the community.	2		No	No	0.0
3.2.1. Field investigations and experimental manipulations.	2		No	No	0.0
3.2.2. Laboratory studies.	2		Yes	No	1.2
4. Quantify, through research, spikedace habitat needs and the effects of physical habitat modification on life cycle completion.					
4.1. Substrate.	2	Various studies.	Yes	No	1.0
4.2. Velocity and depth.	2	Various studies.	Yes	No	1.2
4.3. Water temperature.	2	Studies at University of Arizona (U of A).	Yes	No	2.0
4.4. Water chemistry.	2		No	No	0.0
4.5. Interactions among 4.1-4.3.	2		No	No	0.0
4.6 Watershed size and flood frequency and volume.	2		No	No	0.0
5. Enhance or restore habitats occupied by depleted populations.					
5.1. Identify target areas amenable to management.	2	Desert Fishes Recovery Team; CAP recovery program; DFT report 1.	Yes	No	2.2
5.2. Determine necessary habitat and landscape improvements.	2		Yes	No	2.0
5.3. Implement habitat improvement.	3	Restriction of livestock grazing from occupied habitats.	Yes	No	0.7
6. Reintroduce populations to selected streams within historic range.					
6.1. Identify stocks amenable to use for reintroduction.	3	Recovery Plan, Desert Fishes Recovery Team, CAP recovery program.	Yes	Yes	3.2
6.2. Identify river or stream systems for reintroductions.	3	Recovery Plan, Desert Fishes Recovery Team, CAP recovery program.	Yes	Yes	3.2
6.2.1. Determine suitability of habitat.	3	2001 critical habitat designation.	Yes	No	1.8
6.2.2. Enhance habitat as necessary (4, 5.3).	3		No	No	0.0

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
6.2.3. Assess status of nonnative fishes in the watershed.	3	Fossil Creek, Redfield & Hot Springs Canyons.	Yes	No	2.0
6.2.4. Assure closure of potential immigration routes to preclude reinvasion by nonnative fishes.	3	Barrier in Fossil Creek completed, others in progress.	Yes	No	1.0
6.2.5. Reclaim as necessary to remove nonnative fishes.	3	Fossil Creek renovated in 2004.	Yes	No	0.8
6.3. Reintroduce spikedace to selected reaches.	3		No	No	0.0
6.4. Monitor success/failure of reintroductions.	3		N/A		
6.5. Determine reasons for success/failure.	3		N/A		
6.6. Rectify as necessary causes(s) of failure and restock.	3		N/A		
7. Determine quantitative criteria for describing a self-sustaining population.					
7.1. Acceptable levels of natural variation.	2		No	No	0.0
7.1.1. Absolute numbers.	2		No	No	0.0
7.1.2. Age-class structure.	2		No	No	0.0
7.1.3. Reproduction.	2		No	No	0.0
7.1.4. Recruitment.	2		No	No	0.0
7.2. Minimum stock size.	2		No	No	0.0
7.3. Environmental variables.	2		No	No	0.0
7.3.1. Physical characteristics.	2		No	No	0.0
7.3.2. Chemical characteristics.	2		No	No	0.0
7.3.3. Biological community.	2	Healthy spikedace populations are incompatible with nonnative fishes.	Yes	No	1.4
8. Plan and conduct investigations on captive holding, propagation and rearing					

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
8.1. Determine wild stocks suitable for contribution to hatchery stocks.	3	Desert Fishes Recovery Team, CAP recovery program. NFCT meetings.	Yes	Yes	3.7
8.2. Collect and transfer wild stocks to suitable facility.	3	Attempts at Verde River and Eagle Creek.	Yes	No	1.4
8.3. Develop procedures and facilities for holding and maintaining.	3	Bubbling Ponds State Fish Hatchery through CAP recovery program; UofA studies.	Yes	No	2.3
8.4. Evaluate potential techniques for propagation.	3	Bubbling Ponds State Fish Hatchery through CAP recovery program; UofA studies.	Yes	No	2.3
8.5. Assess life-cycle requirements in hatchery environment.	3		Yes	No	1.8
8.6. Supply individuals as needed for reintroduction, research, public educations, etc.	3		No	No	0.0
9. Information and education					
9.1. Public sector.	2	CAP recovery program funding to AZGFD -- video and trinkets.	Yes	No	1.2
9.1.1. Local media and target campaigns.	2	CAP recovery program funding to AZGFD -- video and trinkets.	Yes	No	1.2
9.1.2. States of Arizona and New Mexico.	2		No	No	1.0
9.1.3. National exposure.	2		Yes	No	0.8
9.1.4. Assist appropriate Mexican agencies and organizations in information and education.	2		No	No	0.0
9.1.5. Open communication among States, Federal agencies, and local residents and water users.	2	Desert Fishes Recovery Team; Native Fishes Conservation Team; participation in misc. watershed groups, etc.	Yes	No	1.2
9.2. Professional information.	2		Yes	No	1.8

Spikedace Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
9.2.1. Open circulation of information among concerned parties.	2	Decreasing.	Yes	No	2.0
9.2.2. Periodic information-exchange meetings.	2		No	No	1.8
9.2.3. Presentations at professional, scientific meetings.	2	Various.	Yes	No	2.2
9.2.4. Publication in peer-reviewed, open literature.	2	Various academic works, publication of agency efforts low.	Yes	No	2.0

Woundfin

Plagopterus argentissimus

Objective and criteria

The primary objective of the recovery plan is to prevent the extinction of the woundfin and Virgin River chub and then to secure each species' survival. Achievement of these objectives involves securing and enhancing currently occupied habitats so that they will support self-sustaining populations and reestablishing self-sustaining populations in other locations (Table 14)*. The long-term goal is to downlist these species to threatened status. This will occur through implementation of the recovery actions and tasks proposed below and is expected to occur by 2015. It is not certain that the two species can be recovered sufficiently to the point where delisting is possible. This is due to the irretrievable loss and degradation of the majority of their habitat and the existing and future pressures from water development. The following reclassification criteria are preliminary and may be revised on the basis of new information.*

Downlisting criteria

The woundfin may be considered for downlisting to threatened when:

(1) Virgin River flows essential to the survival of all life stages of the species are ensured. This will include development and implementation of operational criteria for existing dams, reservoirs, and diversions that provide for flows sufficient to sustain all life stages near historic levels of abundance; acquisition of priority water rights to ensure instream flows of sufficient water quality and quantity from Pah Tempe Springs downstream t Lake Mead to ensure the species' survival; and agreements to ensure passage, timing, and magnitude of flows necessary for channel maintenance during appropriate periods of the year;

(2) Degraded Virgin River habitats from Pah Tempe Springs to Lake Mead are improved and maintained to allow continued existence of all life states at viable population levels; and

(3) Barriers to upstream movements of introduced fishes are established, and red shiners and other nonnative species that present a major threat to the continued existence of the native fish community are eliminated upstream of those barriers.

Interim delisting criteria

The woundfin may be considered for delisting when:

(1) Two additional self-sustaining populations are established in the wild within its historical range. This will require that adequate protection of available habitat and instream flows are maintained, the populations have been self-sustaining for a minimum of 10 consecutive years, and a plan for genetic exchange between the populations has been developed and implemented. Quantitative criteria and timeframes for defining self-sustaining in more detail will be determined as more information becomes available.

(2) Essential habitats, important migration routes, required streamflows, and water quality of both the Virgin River habitat and the habitat of transplanted populations are legally protected, and the threats of other significant physical, chemical, or biological modification such that the habitat would become unsuitable for the woundfin are removed.

Delisting criteria for the woundfin are considered interim because the opportunity and the potential locations for reestablishment of additional populations are uncertain.

The estimated date for downlisting of woundfin is 2015. A delisting date cannot be determined until final criteria are developed.

Table 14. Tasks and priorities identified in recovery plan for woundfin *Plagopterus argentissimus* and accomplishments of tasks within the Gila River basin.

Woundfin Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.0 Maintain and enhance native fish communities of the Virgin River chub and woundfin[14].					
2.0 Protect and enhance habitat for the native Virgin River fish communities[15].					
3.0 Establish additional populations of woundfin and Virgin River chub within their historic range.					
3.1 Maintain genetically appropriate broodstocks and refugia populations of woundfin and Virgin River chub at a minimum of two facilities.	1	Dexter NFH&TC&TC holds stocks. No refugia populations in Gila River basin.	Yes	No	2.0
3.2 Identify and prioritize proposed reintroduction sites.	2	Verde, Hassayampa, Gila, and San Francisco rivers and Tonto Creek identified in recovery plan[16], but not prioritized.	Yes	No	1.4

[14] Task 1 includes 10 subtasks that are applicable solely to the Virgin River, and will not be listed here.
[15] Task 2 includes 14 subtasks that are applicable solely to the Virgin River, and will not be listed here.
[16] Recovery plan recommends withdrawal of 1985 experimental-nonessential designation for waters in Gila River basin.

Woundfin Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
3.3 Conduct baseline habitat assessments of proposed reintroduction sites.	2		No	No	0.0
3.4 Develop and establish reintroduction protocols for woundfin and Virgin River chub.	2		No	No	0.0
3.5 Implement and monitor reintroduction of woundfin and Virgin River chub.	2		No	No	0.0
4.0 Determine ecological requirements of native virgin River fishes with emphasis on woundfin and Virgin River chub[17].					
5.0 Develop and implement educational and informational programs highlighting recovery needs and ongoing efforts for Virgin River fishes.					
5.0 I & E	3		Yes	No	0.3

Gila topminnow

Poeciliopsis occidentalis

1984 Recovery Plan

Recovery goal: *To remove the Gila and Yaqui topminnow from the Federal list of endangered and threatened species by restoring them as secure, stable, self-sustaining, and separate subspecies throughout a significant portion of their historic range[18].*

Recovery criteria: *Criteria for the down listing of the Gila topminnow are based on the successful reintroduction of 20 new populations. Prior to 1987, delisting criteria are based on securement of at least 50 percent of the natural (or reclaimed) populations, plus the successful reintroduction of 50 new populations. If by 1987, attempts to secure protection for 50 percent of the natural populations have failed, then delisting will be initiated solely on the basis of the successful reintroduction of 50 new populations.*

Management Actions (Table 15)***:***

Major steps needed to meet the recovery criteria include:

1. *Monitoring and management of natural, reclaimed and reintroduced populations;*
2. *Surveying for undiscovered populations.*
3. *Removal of Gambusia affinis and other exotic fishes from topminnow habitats, and prevention of their reintroduction.*
4. *Reintroduction of topminnow within their historic range.*
5. *Acquisition of management rights or protective agreements for natural populations located on privately owned lands.*
6. *Research into topminnow/mosquitofish, and topminnow/multiple-use-*

[17] Task 4 includes 10 subtasks that are applicable solely to the Virgin River, and will not be listed here.

[18] In 1984, Gila and Yaqui topminnow were considered subspecies of *P. occidentalis*. Taxonomic and genetic information has now resulted in their description as separate species: *P. occidentalis* and *P. sonoriensis*, respectively.

management relationships (USFWS 1984c).

1999 Recovery Plan draft revision (for comparison purposes—not part of analysis)

Recovery Objectives: *Delisting of the subspecies is not considered feasible in the foreseeable future. The short-term goal of this plan is to prevent extirpation of the species from its natural localities in the U.S. and reintroduce it into suitable habitat within its former range. Down listing of the Gila topminnow in the United States is possible. Recovery to a level of threatened is realistically estimated to take 20 years. The recovery category for this species is 9C.*

Recovery Criteria: *Down listing of the Gila topminnow will be considered when: 1) Survival of the species in the U.S. is ensured by protecting existing natural populations and maintaining refugia stocks from each; 2) Populations are reestablished within the species' historic range according to guidelines identified in this plan; 3) Protocols for population, habitat and genetic monitoring are developed, funded, and started. Natural (Level 1) populations and mixed populations will be established in Level 2 and Level 3 sites as described in the recovery section of this plan. Level 2 populations will be considered established only when they have persisted a minimum of 10 years.*

Actions Needed:

1. Prevent extinction by protecting remaining natural and long-lived reestablished populations.
2. Reestablish and protect populations throughout historic range.
3. Monitor natural and reestablished populations and their habitats.
4. Develop and implement genetic protocol for managing populations.
5. Study life history, genetics, ecology, and habitat of Gila topminnow and interactions with nonnative aquatic species.
6. Inform and educate the public and resource managers (USFWS 1999).

Table 15a. Tasks and priorities identified in recovery plan for Gila topminnow *Poeciliopsis occidentalis* and accomplishments of tasks within the Gila River basin.

Gila topminnow Task	**Priority**	**Accomplishments**	**Task initiated**	**Task completed**	**Subtask score**
1.0 Maintain, protect and enhance existing natural populations and habitats of the Gila and Yaqui topminnow.					
1.1 Monitor existing populations and their habitats.	2	Generally done except on tribal lands, for which data are proprietary and extent of activity is unknown.	Yes	No	3.0
1.11 Recommend timing, frequency, and duration of monitoring.	2		Yes	Yes	3.4
1.12 Establish minimum data to be collected on populations and habitats.	2		Yes	Yes	3.4
1.13 Collect data.	2		Yes	Yes	2.9

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.14 Provide for data distribution.	2	Monitoring data is distributed only about every 5 years. Data acquired on tribal lands not generally available.	Yes	Yes	2.6
1.2 Manage existing habitats on publicly owned lands.	2	Gila topminnow in upper Santa Cruz River and Sharp Spring, (now on State land) likely extirpated, declining in Redrock Canyon.	Yes	No	1.8
1.21 Develop and implement habitat management plans for all existing topminnow habitats.	2	General land management planning. Nothing specific to Gila topminnow.	Yes	No	1.1
1.211 Regulate land and water uses for the benefit of topminnow.	2	Redrock Canyon and Cienega Creek livestock grazing exclosures, road closures.	Yes	No	1.1
1.212 Enhance and improve existing habitats.	3	Cienega Creek stream reconstruction; Redrock Canyon deflectors.	Yes	No	1.3
1.213 Prevent introduction or invasion of nonnative fishes into topminnow habitats.	1	Closure of Cienega Creek to angling.	Yes	No	1.3
1.2131 Build and maintain barriers against invasion by nonnative fishes.	1	Planning for Redrock, San Rafael, and possibly Fresno barriers. Construction of Bylas and Cottonwood Spring barrier.	Yes	No	1.3
1.2132 Prohibit the introduction of *Gambusia affinis* and other nonnative fishes into topminnow habitats.	1	Stocking of fish into wild habitats requires permit from AZGFD.	Yes	No	0.6
1.2133 Petition the Arizona Game and Fish Department to remove *Gambusia affinis* as a legal baitfish in the State of Arizona.	1	Fishing regulations limit use of mosquitofish in some waters of Gila River basin.	Yes	No	1.0

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.214 Remove *Gambusia affinis* and/or other undesirable nonnative fishes from topminnow habitats when detrimental.	1	Done at Bylas Springs, plus others are proceeding through compliance process.	Yes	No	0.7
1.22 Review and comment upon all proposed projects which might affect topminnow or their habitat on publicly owned lands.	1	Section 7 consultation on most projects on Federal lands; some comment on projects on State lands.	Yes	Yes	2.6
1.3 Manage existing habitat on privately owned lands cooperatively with the landowners.	2	Bylas Springs/Salt Creek renovations, habitat reconstruction, barriers. Cottonwood Spring fencing, erosion control, barrier.	Yes	No	1.3
1.31 Obtain management rights through cooperative management agreements, conservation easements, incentive programs, fee simple purchase, etc.	2	Cottonwood Springs Partner's for Wildlife agreement. Fresno and Coal Mine Canyons and Sharp Spring acquisition by State. TNC/State conservation agreement on Sheehy and Sharp springs, and upper Santa Cruz River.	Yes	No	1.3
1.32 Develop and implement habitat management plans for all existing topminnow habitats.	2	BLM's Las Cienegas has plan.	No	No	0.5
2.0 Continue surveying waters in the Gila River drainage and United States portion of the Yaqui River drainage for undiscovered populations of topminnow.					
2.0 Survey for undiscovered populations.	3		Yes	No	2.0
2.1 Identify areas of high potential.	3		Yes	No	2.1
2.2 Recommend means of surveying.	3		Yes	Yes	3.4
2.3 Protect any populations found.	3	Fresno, Coal Mine Canyon acquisition and management.	Yes	Yes	2.5
3.0 Maintain stocks of Gila and Yaqui topminnow at Dexter NFH&TC.					

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
3.0 Maintain stocks of Gila and Yaqui topminnow at Dexter NFH&TC.	1	One stock at Dexter NFH&TC, one at Boyce-Thompson Arboretum. Other stocks at ASU under agreement with USBR.	Yes	No	2.2
4.0 Reintroduce Gila and Yaqui topminnow into suitable sites within the United States portion of their historic ranges.					
4.1 Enter into cooperative agreements with public agencies for the reintroduction of topminnow onto public lands.	3	Various levels of agreement.	Yes	No	1.9
4.11 Develop evaluation criteria for site selection.	3	Criteria informal and based on availability.	Yes	Yes	3.0
4.12 Survey, evaluate, and select potential sites.	3		Yes	No	2.3
4.13 Prepare selected sites.	3	Arnett and Fossil creeks barrier & renovation. Sabino Canyon renovated.	Yes	No	1.4
4.14 Transplant topminnow into the selected sites.	3	11 successful transplants (4 meet criteria of persistence for 3 years, 1 is outside of historic range), 3 augmentation stockings; 10 unsuccessful transplants (2 were outside historic range).	Yes	No	1.4
4.15 Monitor the transplanted populations and their habitat.	3		Yes	Yes	3.0
4.151 Recommend timing, frequency, and duration of monitoring.	3		Yes	Yes	3.5
4.16 Prepare habitat management guidelines for topminnow reintroduction sites.	3		Yes	No	1.4
4.17 Develop and refine a Topminnow Habitat Profile.	3	No longer considered a needed task.	Yes	No	0.6

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
4.2 Obtain rights to reintroduce and manage topminnow on private lands through cooperative management agreements, conservation easements, fee simple purchase, etc.	3	Safe Harbor Agreement for 3 Aravaipa south rim transplants.	Yes	No[19]	1.3
5.0 Initiate and support further studies of the Gila and Yaqui topminnow.					
5.1 Study the mechanisms of topminnow-mosquitofish coexistence.	2		No	No	0.0
5.2 Study the effects of the cannibalism on juveniles noted in hatchery and laboratory stocks of topminnow.	3		No	No	0.0
5.3 Study the relationships between topminnow populations and multiple use management, particularly livestock.	3		No	No	0.0
6.0 Enforce all State and Federal laws protecting topminnow populations and their habitat.					
6.0 Enforce all State and Federal laws protecting topminnow populations and their habitat.	2	Section 9 (ESA) never successfully enforced for take incidental to land and water manipulations. Partial compliance with Section 7 (ESA), but lessening with new policies re voluntary compliance or programmatic approaches.	Yes	No	2.3
7.0 Develop public support through an information and education program.					
7.1 Develop an interpretive program at the San Bernardino National Wildlife Refuge and other public areas.	3	School ponds and some public areas support populations of Gila topminnow, although interpretation is often lacking. General information (videos, brochures, etc.) available, as are trinkets.	Yes	No	1.7

[19] Safe Harbor Agreement in preparation

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
7.2 Develop a program of contact with and education of private landowners.	3		No	No	0.0
7.3 Encourage the use of topminnow as mosquito control agents within their historic range.	3	U.S. Bureau of Reclamation (Reclamation) study. Habitat Conservation Plan to allow topminnow use for mosquito control in process.	Yes	No	1.9
7.4 Prepare an information pamphlet.	3	Brochures and trinkets by AZGFD.	Yes	Yes	3.7
7.5 Develop a slide talk.	3	Occasional talks to various groups by biologists.	Yes	No	1.8
7.6 Provide information to the news media.	3		Yes	No	2.0
7.7 Display populations of Gila topminnow at locations within their historic range.	3	Numerous school yard ponds stocked with topminnow. ESA has special requirements for scientific display of endangered species.	Yes	No	1.2

Table 15b. Tasks and priorities identified in draft revised recovery plan for Gila topminnow *Poeciliopsis occidentalis* and accomplishments of tasks within the Gila River basin[20].

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1. Prevent extinction by protecting remaining natural and long-lived reestablished populations.					
1.1. Maintain refugia populations of natural populations to ensure survival of the species.	1				
1.2. Designate critical habitat for Gila topminnow which will include, as a minimum, all natural populations.	1				

[20] Because the revised recovery plan had not been approved by the USFWS at the time of this report, we chose not to analyze accomplishments of its tasks and subtasks.

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.3. Identify extent of geographic distribution of natural and long-lived reestablished populations including natural populations for which existence is in doubt.	1				
1.4. Protect habitats occupied by natural and long-lived reestablished populations from detrimental land and water use practices.	1				
1.5. Protect remaining natural and long-lived reestablished populations from invasion by detrimental nonnative aquatic species.	1				
1.6. Prohibit the introduction or release of nonnative aquatic species detrimental to Gila topminnow into areas occupied by natural or long-lived reestablished populations.	1				
1.7. Design and implement site specific management plans for natural and long-lived reestablished populations.	1				
1.8. Determine minimum viable population.	1				
2. Reestablish and protect populations throughout historic range.					
2.1. Identify habitats suitable for reintroduction of Gila topminnow.	1				

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.	1				
2.3. Protect habitats suitable for reestablishment from detrimental land and water use practices.	1				
2.4. Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.	1				
2.5. Prohibit the introduction and release of nonnative aquatic species into areas occupied by reestablished populations or identified as potential habitat for reestablished populations.	1				
2.6. Design and implement site specific management plans for all reestablished populations.	1				
3. Monitor natural and reestablished populations and their habitats.					
3.1. Develop standardized population and habitat monitoring protocols and implement them.	1				
3.2. Maintain a population and habitat database and generate annual reports.	1				

Gila topminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
3.3. Implement criteria for declaring reestablished populations as extirpated.	1				
4. Develop and implement genetic protocol for managing populations.					
4.1. Facilitate genetic exchange among reestablished populations if needed.	2				
4.2. Conduct additional genetic studies of natural and reestablished populations.	2				
5. Study life-history, genetics, ecology, and habitat of Gila topminnow and interactions with nonnative aquatic species.	2				
6. Inform and educate the public and resource managers.	3				

Colorado pikeminnow
Ptychocheilus lucius

Recovery Objective: *Delisting. Each Colorado Pikeminnow Recovery Area (Recovery Area) can be delisted as recovery objectives are achieved.*

Recovery Criteria: *Each Recovery Area will remain listed until such time as their recovery criteria are met. The species can be down listed or delisted when all Recovery Areas have been down listed or delisted. The Colorado pikeminnow will be considered eligible for reclassification to threatened when naturally self-sustaining populations are maintained in the Upper Basin in the following Recovery Areas:*

> *(a) The Green River sub basin including the Green River from its confluence with the Colorado River to its confluence with the Yampa River, the lower 220 km (137 miles) of the Yampa River, and the lower 240 km (150 miles) of the White River;*
> *(b) The Colorado River from Palisade, Colorado, to Lake Powell; and*
> *(c) The San Juan River from Lake Powell upstream to the confluence of the Animas River near Farmington, New Mexico.*

(The Colorado pikeminnow may be down listed separately by Recovery Area with the Green River and Colorado River areas being down listed concurrently.)

The Colorado pikeminnow will be considered eligible for delisting when:

(a) Down listing criteria have been met;
(b) a population in either the Salt River from a diversion dam upstream of Roosevelt Lake to Apache Falls or in the Verde River from Horseshoe Reservoir upstream to Paulden, Arizona, is reestablished and habitats and flows are protected. Feasibility of this effort will be reevaluated at the conclusion of the 1995 Lower Basin Agreement. At that time, the need for inclusion of these areas in the delisting criteria will be reconsidered;
(c) the threat of significant fragmentation (e.g., fragmentation that would impair the reproductive success of the population or limit/impact the adult population size) is removed;
(d) essential habitats, primary migration routes, required stream flows, and necessary water quality are legally protected; and
(e) other identifiable threats, if any, which may significantly affect the population are removed.

(The Colorado pikeminnow may be delisted separately by Recovery Area, with the Green River and Colorado River areas being delisted concurrently.)

Actions Needed (Table 16)***:*** *Major actions needed to achieve the recovery of the Colorado pikeminnow are:*

1. *Monitor population status and define the life history requirements of the Colorado pikeminnow.*
2. *Implement management plans to protect and maintain Colorado pikeminnow populations and their habitat.*
3. *Reintroduce Colorado pikeminnow into their historic range.*
4. *Promote and encourage improved communication and information dissemination.*
5. *Determine biological criteria/objectives for down listing/delisting the Colorado pikeminnow.*

Date of Recovery: *The goal of the implementation program is to recover these Colorado River fishes in the Upper Basin area in 15 years at an estimated cost of $53 million. Development of an endangered fishes management program for the lower basin is being planned. (USFWS 1991a).*

Recovery Objective: *Down listing and Delisting.*

Recovery Criteria: *Objective, measurable criteria for recovery of Colorado pikeminnow in the Colorado River Basin are presented for the Upper Colorado River Basin (including the Green River, upper Colorado River, and San Juan River sub basins). Recovery of the species is considered necessary only in the upper basin because of the present status of populations and because existing information on Colorado pikeminnow biology support application of the metapopulation concept to extant populations. The need for self-sustaining populations in the lower basin and associated site-specific management actions/tasks necessary to minimize or remove threats will be reevaluated at the status review of the species, which is conducted at least once every 5 years (provisional recovery criteria for the lower basin are appended). The Colorado pikeminnow was listed prior to the 1996 distinct population segment (DPS) policy. If*

lower basin populations are determined necessary for recovery, the Service may conduct an evaluation to designate DPSs in a future rule-making process. If DPSs are designated, these recovery criteria will need to be reevaluated. These recovery goals are based on the best available scientific information, and are structured to attain a balance between reasonably achievable criteria (which include an acceptable level of uncertainty) and ensuring the viability of the species beyond delisting. Additional data and improved understanding of Colorado pikeminnow biology may prompt future revision of these recovery goals.

Down listing can occur if, over a 5-year period, the upper basin metapopulation is maintained such that: (1) a genetically and demographically viable, self-sustaining population is maintained in the Green River sub basin such that — (a) the trends in separate adult (age 7+; >450 mm TL) point estimates for the middle Green River and the lower Green River do not decline significantly, and (b) mean estimated recruitment of age-6 (400–449 mm TL) naturally produced fish equals or exceeds mean annual adult mortality for the Green River sub basin, and (c) each population point estimate for the Green River sub basin exceeds 2,600 adults (2,600 is the estimated minimum viable population [MVP] needed to ensure long-term genetic and demographic viability); and (2) a self-sustaining population of at least 700 adults (number based on inferences about carrying capacity) is maintained in the upper Colorado River sub basin such that — (a) the trend in adult point estimates does not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality; and (3) a target number of 1,000 age-5+ fish (>300 mm TL); number based on estimated survival of stocked fish and inferences about carrying capacity) is established through augmentation and/or natural reproduction in the San Juan River sub basin; and (4) when certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.

Delisting can occur if, over a 7-year period beyond down listing, the upper basin metapopulation is maintained such that: (1) a genetically and demographically viable, self-sustaining population is maintained in the Green River sub basin such that — (a) the trends in separate adult point estimates for the middle Green River and the lower Green River do not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality for the Green River sub basin, and (c) each population point estimate for the Green River sub basin exceeds 2,600 adults; and (2) either the upper Colorado River sub basin self-sustaining population exceeds 1,000 adults ***OR*** *the upper Colorado River sub basin self-sustaining population exceeds 700 adults and San Juan River sub basin population is self-sustaining and exceeds 800 adults (numbers based on inferences about carrying capacity) such that for each population — (a) the trend in adult point estimates does not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality; and (3) when certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.*

Conservation plans will go into effect at delisting to provide for long-term management and protection of the species, and to provide reasonable assurances that recovered Colorado pikeminnow populations will be maintained without the need for relisting. Elements of those plans could include (but are not limited to) provision of flows for maintenance of habitat conditions required for all life stages, regulation and/or control of nonnative fishes, minimization of the risk of hazardous-materials spills, and monitoring of populations and habitats. Signed agreements among State agencies, Federal agencies, American Indian tribes, and other interested parties must be in place to implement the conservation plans before delisting can occur.

Management Actions Needed:

1. Provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations.
2. Provide passage over barriers within occupied habitat to allow adequate movement and, potentially, range expansion.
3. Investigate options for providing appropriate water temperatures in the Gunnison River.
4. Minimize entrainment of sub adults and adults in diversion canals.
5. Ensure adequate protection from over utilization.
6. Ensure adequate protection from diseases and parasites.
7. Regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries.
8. Control problematic nonnative fishes as needed.
9. Minimize the risk of hazardous-materials spills in critical habitat.
10. Remediate water-quality problems.
11. Provide for the long-term management and protection of populations and their habitats beyond delisting (i.e., conservation plans).

Estimated Time to Achieve Recovery: *Reliable population estimates, based on a multiple mark-recapture model, are needed for all populations over a 5-year monitoring period for down listing and over a 7-year monitoring period beyond down listing in order to achieve delisting. The accuracy and precision of each point estimate will be assessed by the Service in cooperation with the respective recovery or conservation programs, and in consultation with investigators conducting the point estimates and with qualified statisticians and population ecologists. First point estimates were completed for all populations in 2001. The Service is reviewing those estimates for reliability, and, if they are accepted by the Service and all recovery criteria are met, down listing could be proposed in 2006 and delisting could be proposed in 2013. This estimated time frame is based on current understanding of the status and trends of populations and on the monitoring time required to meet the down listing and delisting criteria (USFWS 2002b).*

Table 16a. Tasks and priorities identified in recovery plan for Colorado pikeminnow *Ptychocheilus lucius* and accomplishments of tasks within the Gila River basin.

Colorado pikeminnow Task	**Priority**	**Accomplishments**	**Task initiated**	**Task completed**	**Subtask score**
1. Monitor population status and define the life history requirements of the Colorado pikeminnow.					
11. Monitor Colorado pikeminnow populations.					
111. Compile and analyze population data.	2		N/A	N/A	N/A
112. Develop standardized monitoring procedures.	2		N/A	N/A	N/A
113. Determine population status and trends.	2		N/A	N/A	N/A
12. Research and expand the life history information.					

Colorado pikeminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
121. Refine information related to life history/spawning and recruitment requirements.	2		N/A	N/A	N/A
122. Assess inter-/intraspecific interactions.	2		N/A	N/A	N/A
123. Develop aging techniques and determine age distribution and growth rates.	2		N/A	N/A	N/A
124. Identify cues for and importance of migration.	2		N/A	N/A	N/A
13. Develop and implement standardized procedures for data collection, management, and analysis.	2		N/A	N/A	N/A
14. Develop annual work plans for high priority research and monitoring activities for interagency review.	2		N/A	N/A	N/A
2. Develop and implement management plans to protect and maintain Colorado pikeminnow populations and their habitat.					
21. Determine threats to and protect Colorado pikeminnow populations and their habitat.					
211. Monitor and assess the impact of development projects.	1		N/A	N/A	N/A
212. Identify and assess the impacts of introduced nonnative species which compete with or impact the Colorado pikeminnow.	1		N/A	N/A	N/A
213. Monitor the extent of parasitism and disease in the Colorado pikeminnow.	1		N/A	N/A	N/A
214. Determine effects of environmental contaminants on Colorado pikeminnow and their habitat.	1		N/A	N/A	N/A
22. Refine and enforce existing laws and regulations protecting the Colorado pikeminnow.					
221. Inform appropriate agencies of their enforcement responsibilities.	1		N/A	N/A	N/A

Colorado pikeminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
222. Ensure compliance with Section 7 of the Endangered Species Act by all Federal Agencies.	1		N/A	N/A	N/A
223. Assess effectiveness of current regulations/management and draft additional regulations or increase protection and enforcement as needed.	1		N/A	N/A	N/A
224. Discontinue or prevent introductions of nonnative fish species which have a negative impact on the Colorado pikeminnow.	1		N/A	N/A	N/A
225. Minimize incidental take of all life stages of Colorado pikeminnow, especially that associated with sport fishing, seining for bait, and stranding in irrigation ditches.	1		N/A	N/A	N/A
23. Identify and monitor all sensitive habitat.					
231. Conduct field investigations to locate and further define sensitive habitat (i.e., spawning and rearing areas, etc.).	1		N/A	N/A	N/A
232. Determine biological, chemical, and physical components for sensitive habitat types.	1		N/A	N/A	N/A
233. Define flow, temperature, and substrate requirements.	1		N/A	N/A	N/A
234. Establish criteria to identify suitable habitat (i.e., timing, duration, and microhabitat).	1		N/A	N/A	N/A
24. Manage and restore primary Colorado pikeminnow habitat.					
241. Assess impacts of existing water development projects and make recommendations to improve habitat conditions for Colorado pikeminnow.	1		N/A	N/A	N/A

Colorado pikeminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
242. Evaluate fish passage as a method to restore use by and movement of Colorado pikeminnow within their former range where dams now restrict movement.	1		N/A	N/A	N/A
243. Determine effectiveness of enhancing Colorado pikeminnow spawning and rearing success through habitat improvement.	1		N/A	N/A	N/A
244. Ensure that essential habitats, migration routes, streamflow, and adequate water quality are legally protected.	1		N/A	N/A	N/A
25. Develop and implement cooperative interagency programs to protect and recover the Colorado pikeminnow.	2		N/A	N/A	N/A
3. Reintroduce Colorado pikeminnow into their historic range.					
31. Develop capabilities to produce adequate numbers of Colorado pikeminnow for research and management.					
311. Develop or improve propagation, holding, and rearing techniques to optimize production.	2	Ongoing at Dexter NFH&TC and elsewhere.	Yes	No	3.3
312. Maintain a diversified gene pool.	2		Yes	No	1.3
32. Conduct reintroduction programs in the Lower Basin.					
321. Identify areas for reintroduction/augmentation.	1	Identified but not evaluated. Focus is limited to upper Colorado River basin. Upper Gila has potential.	Yes	No	2.5
322. Restore or prepare stocking sites as needed.	1		Yes	No	0.5
323. Stock and monitor reintroduced/stocked populations.	1	Repatriation efforts into Salt and Verde Rivers. Some monitoring.	Yes	No	2.3
33. Conduct augmentation/reintroduction program in the Upper Basin.					

Colorado pikeminnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
331. Assess the role of artificial propagation of Colorado pikeminnow in providing fish for research and for augmentation stocking.	1		N/A	N/A	N/A
332. Conduct reintroduction/augmentation programs.	1		N/A	N/A	N/A
4. Promote and encourage improved communication and information dissemination.					
41. Conduct nationwide information and education program.	3		Yes	No	1.2
42. Conduct local information and education programs.					
421. Minimize incidental take of pikeminnow through information and education programs.	3	Angling regulations on Verde River.	Yes	No	1.4
422. Assess the sport fishery potential for Colorado pikeminnow.	3		No	No	0.0
43. Promote information and education programs within management agencies.	3		Yes	No	1.2
44. Encourage and support publication of research and other recovery results in the technical literature.	3		Yes	No	1.4
5. Determine biological criteria/objectives for down listing/delisting the Colorado pikeminnow.					
51. Define naturally self-sustaining populations.	3		Yes	No	2.3
52. Establish quantifiable objectives for down listing and delisting.	3	"Provisional" in amendment.	Yes	Yes	4.0

Table 16b. Tasks identified in recovery supplement and amendment for Colorado pikeminnow *Ptychocheilus lucius* and accomplishments of tasks (Provisional site specific management and tasks by recovery factor (lower basin), in appendix B in supplement and amendment) within the Gila River basin.

Colorado pikeminnow (amendment) Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
A-1. Provide flows necessary for all life stages of Colorado pikeminnow to support recovered populations, based on demographic criteria.					

Colorado pikeminnow (amendment) Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
A-1.1. Identify, implement, evaluate, and revise (as necessary through adaptive management) flow regimes that are necessary for the establishment and maintenance of Colorado pikeminnow populations in the main stem and/or tributaries.			N/A		
A-1.2. Provide flow regimes (as determined under Task A-1.1) that are necessary for all life stages of Colorado pikeminnow to support recovered populations in the main stem and/or tributaries.			N/A		
A-2. Minimize entrainment of sub adult and adult Colorado pikeminnow in diversion and/or out-take structures.					
A-2.1. Identify measures (e.g., screens, baffles) to minimize entrainment of sub adult and adult Colorado pikeminnow at problematic diversion and/or out-take structures.			N/A		
A-2.2. Install devices and/or implement other measures (as determined under Task A-2.1) to minimize entrainment.			N/A		
B-1. Protect Colorado pikeminnow populations from over utilization for commercial, recreational, scientific, or educational purposes.					
B-1.1. Reevaluate and, if necessary, identify actions to ensure adequate protection from over utilization of Colorado pikeminnow for commercial, recreational, scientific, or educational purposes; not currently identified as an existing threat (see section 4.2).			N/A		
B-1.2. Implement identified actions (as determined in Task B-1.1) to ensure adequate protection of Colorado pikeminnow from over utilization for commercial, recreational, scientific, or educational purposes.		Special angling regulations on Salt and Verde rivers, I&E program at popular fishing sites.	N/A		
C-1. Minimize adverse effects of diseases and parasites on Colorado pikeminnow populations.					

Colorado pikeminnow (amendment) Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
C-1.1. Reevaluate and, if necessary, identify actions to minimize adverse effects of diseases and parasites on Colorado pikeminnow populations; not currently identified as an existing threat (see sections 4.3.1 and A.11 for discussion of diseases and parasites).			N/A		
C-1.2. Implement identified actions (as determined under Task C-1.1) to ensure adequate protection of Colorado pikeminnow populations from deleterious diseases and parasites.			N/A		
C-2. Regulate nonnative fish releases and escapement into the main stem, floodplain, and tributaries.					
C-2.1. Develop, implement, evaluate, and revise (as necessary through adaptive management) procedures for stocking and to minimize escapement of nonnative fish species into the main stem, floodplain, and tributaries to minimize negative interactions between nonnative fishes and Colorado pikeminnow (see sections 4.3.2 and A.7 for discussion of effects of nonnative fishes).			N/A		
C-2.2. Finalize and implement procedures (as determined under Task C-2.1) for stocking and to minimize escapement of nonnative fish species into the main stem, floodplain, and tributaries to minimize negative interaction between nonnative fishes and Colorado pikeminnow.			N/A		
C-3. Control problematic nonnative fishes as needed					

Colorado pikeminnow (amendment) Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
C-3.1. Develop control programs for problematic nonnative fishes in the main stem, floodplain, and tributaries to identify levels of control that will minimize negative interactions between nonnative fishes and Colorado pikeminnow.			N/A		
C-3.2. Implement identified levels (as determined under Task C-3.1) of nonnative fish control in the main stem, floodplain, and tributaries.			N/A		
D-1. Legally protect habitat (see definition of habitat in section 5.1.2) necessary to provide adequate habitat and sufficient range for all life stages of Colorado pikeminnow to support recovered populations, based on demographic criteria.					
D-1.1. Determine mechanisms for legal protection of adequate habitat through instream-flow rights, contracts, agreements, or other means (see section 4.4 for discussion of regulatory mechanisms).			N/A		
D-1.2. Implement mechanisms for legal protection of habitat (as determined under Task D-1.1) that are necessary to provide adequate habitat and sufficient range for all life stages of Colorado pikeminnow to support recovered populations.			N/A		
D-2. Provide for the long-term management and protection of Colorado pikeminnow populations and their habitats.					
D-2.1. Identify elements needed for the development of conservation plans that are necessary to provide for the long-term management and protection of Colorado pikeminnow populations; elements of these plans may include (but are not limited to) provision of flows for maintenance of adequate habitat conditions for all life stages of Colorado pikeminnow, regulation and/or control of nonnative fishes, and monitoring of populations and habitats (see section 4.4 for discussion of			N/A		

Colorado pikeminnow (amendment) Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
need for conservation plans).					
D-2.2. Develop and implement conservation plans and execute agreements among State agencies, Federal agencies, American Indian tribes, and other interested parties to provide reasonable assurances that conditions needed for recovered Colorado pikeminnow populations will be maintained.			N/A		
E. Other natural or manmade factors for which protection has been provided.					
E-1. Minimize the risk of hazardous-materials spills in critical habitat.		No critical habitat in Gila River basin.	N/A		
E-2. Minimize threats from degraded water quality on Colorado pikeminnow.		No threats identified.	N/A		
E-3. Minimize the effects of selenium contamination on Colorado pikeminnow reproductive success and survival of young and reduce deleterious levels of selenium contamination, if necessary.		Does not apply in Gila River basin.	N/A		

Loach minnow

Tiaroga cobitis

Recovery Objective: *Protection of existing populations, restoration of populations in portions of historic habitat, and eventual delisting, if possible.*

Recovery Criteria: This plan sets forth mechanisms to obtain information necessary to determine quantitative criteria for describing a spikedace population capable of sustaining itself in perpetuity. Delisting is dependent upon establishment of such populations.

Actions needed (Table 17)***:***

1. *Protection existing populations.*
2. *Monitoring of existing populations.*
3. *Studies of interactions of loach minnow and non-native fishes.*
4. *Quantification of habitat and effects of habitat modification.*
5. *Enhancement of habitats of depleted populations.*
6. *Reintroduction of loach minnow into historic range.*
7. *Quantification of characteristics of a self-sustaining population.*
8. *Captive propagation.*

9. Information and education.

Date of Recovery: *Until work is completed to allow quantification of delisting criteria, it is not possible to predict a date of recovery. However, based on the evaluation period of 10 years for determination of success of reintroduced populations, recovery of this species could not occur in less than 20 years (USFWS 1991c).*

Table 17. Tasks and priorities identified in recovery plan for loach minnow *Tiaroga cobitis* and accomplishments of tasks within the Gila River basin.

Loach minnow Task	Priority	Accomplishments	Task initiated	Task completed	Subtask Score
1.0. Protect existing populations of loach minnow.					
1.1. Identify extent of existing populations and level of protection afforded to each.	1	Indian reservations lack recent or comprehensive surveys.	Yes	No	2.8
1.2. Prioritize existing populations as to need or imminent need for protection.	2	Informally addressed by DFT in report 1. All need protection.	Yes	No	2.3
1.3. Designate critical habitat.	1	Designated twice, courts remanded both back to FWS to redo. Reproposed December 2005.	Yes	No	1.2
1.4. Enforce existing laws and regulations affecting loach minnow.					
1.4.1. Inform as necessary appropriate agencies of applicable management/enforcement responsibilities.	1	Ongoing.	Yes	No	2.5
1.4.2. Assure compliance with Section 7 of the Endangered Species Act.	1	FWS policy changes favor programmatic approaches. In general, section 7 compliance is decreasing due to policy shift away from regulation to voluntary compliance.	Yes	No	2.0
1.4.3. Assure compliance with Section 9 of ESA.	1	Ongoing recovery permit administration delegated to State. No HCPs or prosecution of direct take of loach minnow, despite identification of take during non-section 7 land and water modifications.	Yes	No	1.8

1.5. Discourage detrimental land and water use practices.	1	Occurring only incidental to section 7 and other regulatory application. Grazing curtailed along many occupied habitats.	Yes	No	1.3
1.6. Insure perennial flows with natural hydrographs.	1	Aravaipa Creek has instream flow right, Verde River and Fossil Creek have pending applications.	Yes	No	1.3
1.7. Curtail transport and introduction of nonnative fishes.	1	CAP program for management against nonnative aquatics; Fossil Creek renovation; open bag limits on nonnative sport fish in loach minnow habitats in AZ. Introduction and spread of nonnatives continues to increase.	Yes	No	1.2
1.7.1. Discourage seining and use of live bait in streams occupied by loach minnow.	1	Special regulations promulgated by AZGF & NMGF commissions re: use of bait fish.	Yes	No	1.3
1.8. Examine efficacy of barrier construction to preclude invasion by nonnative fishes.	1	Aravaipa Creek barriers; CAP nonnative & recovery program 2005 report on barrier efficacy.	Yes	Yes	2.8
1.9. Identify important, available private lands and water rights not already protected.	2	Lists of lands and water rights have been started.	Yes	No	1.3
1.10. Acquire important lands and associated water rights as they become available.	2	Some acquisition of lands as Federal infill or by TNC or State.	Yes	No	1.2
1.11. Protect acquired lands.	2		Yes	No	1.3
2. Monitor status of existing populations.					
2.1. Establish and implement standard monitoring locations for extant populations.	1	Not initiated/standardized by FWS. No programmatic aspect.	Yes	No	1.8

2.2. Establish and implement standard techniques and their application.	1	Individual streams/personnel have standard techniques, but no overall range-wide standard techniques applied.	Yes	No	2.3
2.3. Establish and maintain a computerized database for tracking of monitoring and reintroduction information.	2	No centralized data base established. Local databases available.	No	No	0.0
2.4. Determine range of natural variation in absolute abundance and age-class structure.	1	Few suitable data, limited evaluation thus far.	Yes	No	1.2
2.4.1. Develop standard methods for quantifying abundance.	1	Available for other species but not done specifically for loach minnow.	Yes	No	1.5
2.4.2. Conduct bi-annual (spring, autumn) population estimates.	1	Most populations monitored only annually. Bi-annual sampling only at Aravaipa.	Yes	No	1.6
2.5. Monitor community composition.	1	During ongoing monitoring.	Yes	No	2.2
2.5.1. Apply standard locations and techniques (2.1, 2.2).	1	Standardized by location but not between locations.	Yes	No	1.7
2.5.2. Determine range of natural variation in relative abundances of community members.	1	Only data for Aravaipa Creek and San Francisco, Tularosa, Gila River Forks, and mainstem in NM analyzed to date.	Yes	No	1.7
2.6. Determine genetic characteristics of existing populations.	1	ASU studies. Data lacking only for populations on tribal lands.	Yes	No	2.8
3. Identify nature and significance of interaction with nonnative fishes.					
3.1. Direct interaction (predation, displacement).	2	Studies at various universities.	Yes	No	1.8
3.1.1. Field investigations and experimental manipulations.	2		Yes	No	1.5
3.1.2. Laboratory studies.	2		Yes	No	1.2
3.2. Indirect interaction (mediated by other fishes of the community.	2		Yes	No	1.2

3.2.1. Field investigations and experimental manipulations.	2		No	No	0.0
3.2.2. Laboratory studies.	2		Yes	No	1.2
4. Quantify, through research, loach minnow habitat needs and the effects of physical habitat modification on life cycle completion.					
4.1. Substrate.	2		Yes	No	1.3
4.2. Velocity and depth.	2		Yes	No	1.5
4.3. Water temperature	2	Studies on water temperature requirements completed at UofA.	Yes	No	2.6
4.4. Water chemistry.	2		No	No	0.0
4.5. Watershed characteristics.	2		No	No	0.0
4.6. Interactions among 4.1-4.4.	2		No	No	0.0
5. Enhance or restore habitats occupied by depleted populations.					
5.1. Identify target areas amenable to management.	2	Desert Fishes Recovery Team; CAP recovery program; DFT report 1.	Yes	No	1.7
5.2. Determine necessary habitat and landscape improvements.	2		Yes	No	1.3
5.3. Implement habitat improvement.	3	Restriction of livestock grazing from occupied habitats.	Yes	No	0.5
6. Reintroduce populations to selected streams within historic range.					
6.1. Identify stocks amenable to use for reintroduction.	3	Recovery Plan, Desert Fishes Recovery Team, CAP recovery program, DFT report 1.	Yes	Yes	3.7
6.2. Identify river or stream systems for reintroductions.	3	Recovery Plan, Desert Fishes Recovery Team, CAP recovery program, DFT report 1.	Yes	Yes	3.3
6.2.1. Determine suitability of habitat.	3		Yes	No	1.9
6.2.2. Enhance habitat as necessary (4, 5.3).	3		No	No	0.0

6.2.3. Assess status of nonnative fishes in the watershed.	3	Some baseline survey data available. Fossil Creek, Redfield & Hot Springs canyons.	Yes	No	1.5
6.2.4. Assure closure of potential immigration routes to preclude reinvasion by nonnative fishes.	3	Barriers on Aravaipa and Fossil creeks constructed, others in planning.	Yes	No	1.2
6.2.5. Reclaim as necessary to remove nonnative fishes.	3	Fossil Creek renovated in 2004.	Yes	No	1.0
6.3. Reintroduce loach minnow to selected reaches.	3		No	No	0.0
6.4. Monitor success/failure of reintroductions.	3		N/A	N/A	
6.5. Determine reasons for success/failure.	3		N/A	N/A	
6.6. Rectify as necessary causes(s) of failure and restock.	3		N/A	N/A	
7. Determine quantitative criteria for describing a self-sustaining population					
7.1. Acceptable levels of natural variation.	2		No	No	0.0
7.1.1. Absolute numbers.	2		No	No	0.0
7.1.2. Age-class structure.	2		No	No	0.0
7.1.3. Reproduction.	2		No	No	0.0
7.1.4. Recruitment.	2		No	No	0.0
7.2. Minimum stock size.	2		No	No	0.0
7.3. Environmental variables.	2		No	No	0.0
7.3.1. Physical characteristics.	2		No	No	0.0
7.3.2. Chemical characteristics.	2		No	No	0.0
7.3.3. Biological community.	2	Absence of non-natives essential for long-term survival.	Yes	No	1.2
8. Plan and conduct investigations on captive holding, propagation and rearing.					

8.1. Determine wild stocks suitable for contribution to hatchery stocks.	3	Desert Fishes Recovery Team, CAP recovery program.	Yes	No	3.2
8.2. Collect and transfer wild stocks to suitable facility.	3	Attempts on Black River and Eagle Creek.	Yes	No	1.2
8.3. Develop procedures and facilities for holding and maintaining.	3	Bubbling Ponds State Fish Hatchery through CAP recovery program, UofA studies.	Yes	No	2.8
8.4. Evaluate potential techniques for propagation.	3	Bubbling Ponds State Fish Hatchery through CAP recovery program, UofA studies.	Yes	No	2.5
8.5. Assess life-cycle requirements in hatchery environment.	3	Bubbling Ponds State Fish Hatchery through CAP recovery program, UofA studies.	Yes	No	2.2
8.6. Supply individuals as needed for reintroduction, research, public educations, etc.	3		No	No	0.0
9. Information and education					
9.1. Public sector.	2	CAP recovery program funding to AZGFD – video and trinkets.	Yes	No	1.2
9.1.1. Local media and target campaigns.	2	CAP recovery program funding to AZGFD – video and trinkets.	Yes	No	1.2
9.1.2. States of Arizona and New Mexico.	2		No	No	1.0
9.1.3. National exposure.	2		Yes	No	0.8
9.1.4. Assist appropriate Mexican agencies and organizations in information and education.	2		Yes	No	0.4
9.1.5. Open communication among States, Federal agencies, and local residents and water users.	2	Desert Fishes Recovery Team, Native Fishes Conservation Team, participation in misc. watershed groups, etc.	Yes	No	1.3
9.2. Professional information.	2		Yes	No	1.8

9.2.1. Open circulation of information among concerned parties.	2	Decreasing.	Yes	No	1.8
9.2.2. Periodic information-exchange meetings.	2		Yes	No	1.5
9.2.3. Presentations at professional, scientific meetings.	2		Yes	No	2.0
9.2.4 Publication in peer-reviewed, open literature.	2		Yes	No	1.8

Razorback sucker

Xyrauchen texanus

Recovery Objectives: *Protection and expansion of three existing populations, and establishment of five new ones from remnant stocks or reintroductions.*

Recovery Criteria: *The three steps for recovery of the razorback sucker to a less endangered status are: prevent immediate extinction, down list to threatened, and delist. The short-term goal, which is to prevent extinction of the razorback sucker, will be considered accomplished when decline of extant stocks in Lake Mohave, the middle Green River and the lower Yampa River has been reversed, those populations are stabilized, and target population sizes are maintained or exceeded for at least 5 years. The long-term goal is to sufficiently recover the fish to allow down listing and then delisting. Down listing to a threatened status would signify that immediate extinction in the wild has been averted, and will be possible when a remnant population has been reestablished in the lower Green River, one additional population has been established in the upper basin, and one additional population has been established either in the upper or lower basin. Delisting will be possible after the fish has been down listed to threatened, and two additional populations have been established and protected. One of these additional populations shall be in the upper and one shall e in the lower basin.*

Actions Needed (Table 18)***:***

(1) Maintain existing genetic diversity in hatchery refugia and increase diversity if possible.
(2) Reverse the decline, increase, and stabilize three existing populations by management actions: Lake Mohave, middle Green River, and lower Yampa River.
(3) Protect habitats of these populations from further degradation.
(4) Restore habitats to make them compatible with recovery goals.
(5) Augment or reestablish five additional populations of the fish in its critical habitat.

Date of Recovery: *The three major populations should be stabilized and the immediate threat of extinction avoided by the year 2000. Down listing may be possible by 2010. Delisting could occur as soon as 2020, if recovery criteria have been met (USFWS 1998b).*

Recovery Criteria: *Objective, measurable criteria for recovery of razorback sucker in the Colorado River Basin are presented for each of two recovery units (i.e., the upper basin,*

including the Green River, upper Colorado River, and San Juan River sub basins; and the lower basin, including the main stem and its tributaries from Glen Canyon Dam downstream to the southerly International Boundary with Mexico) because of different recovery or conservation programs and to address unique threats and site-specific management actions/tasks necessary to minimize or remove those threats. Recovery of the species is considered necessary in both the viii upper and lower basins because of the present status of populations and existing information on razorback sucker biology. Self-sustaining populations will need to be established through augmentation. Without viable wild populations, there are many uncertainties associated with recovery of razorback sucker. The razorback sucker was listed prior to the 1996 distinct population segment (DPS) policy, and the U.S. Fish and Wildlife Service (Service) may conduct an evaluation to designate DPSs in a future rule-making process. These recovery goals are based on the best available scientific information, and are structured to attain a balance between reasonably achievable criteria and ensuring the viability of the species beyond delisting. These recovery criteria will need to be reevaluated and revised after self-sustaining populations are established and there is improved understanding of razorback sucker biology.

Down listing can occur if, over a 5-year period: (1) genetically and demographically viable, self-sustaining populations are maintained in the Green River sub basin and ***EITHER*** *in the upper Colorado River sub basin or the San Juan River sub basin such that — (a) the trend in adult (age 4+; $400 mm TL) point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 (300–399 mm TL) naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 5,800 adults (5,800 is the estimated minimum viable population [MVP] needed to ensure long-term genetic and demographic viability); and (2) a genetic refuge is maintained in Lake Mohave of the lower basin recovery unit; and (3) two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit (e.g., main stem and/or tributaries) such that — (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 5,800 adults; and (4) when certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.*

Delisting can occur if, over a 3-year period beyond down listing: (1) genetically and demographically viable, self-sustaining populations are maintained in the Green River sub basin and ***EITHER*** *in the upper Colorado River sub basin or the San Juan River sub basin such that — (a) the trend in adult point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 5,800 adults; and (2) a genetic refuge is maintained in Lake Mohave; and (3) two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit such that — (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 5,800 adults; and (4) when certain site specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.*

Conservation plans will go into effect at delisting to provide for long-term management and protection of the species, and to provide reasonable assurances that recovered razorback sucker populations will be maintained without the need for relisting. Elements of those plans

could include (but are not limited to) provision of flows for maintenance of habitat conditions required for all life stages, regulation and/or control of nonnative fishes, minimization of the risk of hazardous materials spills, and monitoring of populations and habitats. Signed agreements among State agencies, Federal agencies, American Indian tribes, and other interested parties must be in place to implement the conservation plans before delisting can occur.

Management Actions Needed:

1. Reestablish populations with hatchery-produced fish.
2. Identify and maintain genetic variability of razorback sucker in Lake Mohave.
3. Provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations.
4. Provide passage over barriers within occupied habitat to allow unimpeded movement and, potentially, range expansion.
5. Investigate options for providing appropriate water temperatures in the Gunnison River.
6. Minimize entrainment of sub adults and adults at diversion/out-take structures.
7. Ensure adequate protection from over utilization.
8. Ensure adequate protection from diseases and parasites.
9. Regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries.
10. Control problematic nonnative fishes as needed.
11. Minimize the risk of hazardous-materials spills in critical habitat.
12. Remediate water-quality problems.
13. Minimize the threat of hybridization with white sucker.
14. Provide for the long-term management and protection of populations and their habitats beyond delisting (i.e., conservation plans) (USFWS 2002c).

Table 18a. Tasks and priorities identified in recovery plan for razorback sucker *Xyrauchen texanus* and accomplishments of tasks within the Gila River basin.

Razorback sucker Task	**Priority**	**Accomplishments**	**Task initiated**	**Task completed**	**Subtask score**
1. Prevent extinction of major extant razorback sucker populations and permanent loss of genetic diversity of existing populations[21].					
1.1. Protect fish in refugia and maintain genetic diversity.					
1.1.1. Maintain adequate refugia.	1		N/A	N/A	N/A
1.1.2. Collect razorback suckers for refugia.	1		N/A	N/A	N/A
1.1.3. Manage genetic composition of razorback sucker refugia populations.					
1.1.3.1. Maintain diversity found in wild populations.	1		N/A	N/A	N/A
1.1.3.2. Identify and maintain separate stocks if necessary and determine significance to recovery.	1		N/A	N/A	N/A

[21] There are no extant populations in the Gila River basin.

Razorback sucker Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
1.1.3.3. Determine degree of hybrid introgression and potential for affecting recovery effort.	1		N/A	N/A	N/A
1.2. Restore physical habitats and provide fish access.					
1.2.1. Restore water flows.	1		N/A	N/A	N/A
1.2.2. Restore fish passage.	1		N/A	N/A	N/A
1.2.3. Reduce contaminants.	1		N/A	N/A	N/A
1.3. Reduce adverse biological impacts.					
1.3.1. Control nonnative fish.					
1.3.1.1. Control nonnative fish in razorback habitat.	1		N/A	N/A	N/A
1.3.1.2. Stop movement of nonnative fish into razorback habitat.	1		N/A	N/A	N/A
1.3.1.3. Prevent new introductions on nonnative aquatic species.	1		N/A	N/A	N/A
1.4. Augment wild populations.					
1.4.1. Introduce and protect wild larvae life stages.	1		N/A	N/A	N/A
1.4.2. Introduce and protect juveniles or adults.	1		N/A	N/A	N/A
1.5. Monitor populations and habitat status.					
1.5.1. Develop standardized population monitoring procedures.	1		N/A	N/A	N/A
1.5.2. Implement population monitoring programs.	1		N/A	N/A	N/A
1.5.3. Compile and analyze population data.	1		N/A	N/A	N/A
1.5.4. Monitor habitat	1		N/A	N/A	N/A
1.5.5. Compile and analyze habitat data.	1		N/A	N/A	N/A
2. Establish and protect additional wild populations.					
2.1. Develop criteria for selecting additional recovery areas.	2		Yes	Yes	3.5
2.2. Assess restoration and access needs.					

Razorback sucker Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
2.2.1. Determine flow and water level requirements.	2		No	No	0.0
2.2.2. Determine effects of contaminants.	2		No	No	0.0
2.2.3. Determine nonnative impacts that may limit recovery.	2		Yes	No	2.8
2.2.4. Quantify food abundance.	2		No	No	0.0
2.2.5. Determine annual temperature regimes.	2		No	No	0.0
2.2.6. Identify and evaluate required fish passage.	2		No	No	0.0
2.3. Select additional recovery areas in critical habitat reaches.	2		Yes	Yes	2.6
2.4. Determine habitat restoration needs.					
2.4.1. Identify habitat parameters that may be limiting.	2		Yes	No	1.8
2.4.2. Determine habitat to be restored.	2		No	No	0.0
2.5. Restore needed habitats and provide fish access.					
2.5.1. Restore physical habitat components.					
2.5.1.1. Restore water conditions.	2		No	No	0.0
2.5.1.2. Restore fish passage.	2		No	No	0.0
2.5.1.3. Reduce contaminants.	2		No	No	0.0
2.5.1.4. Reduce effects from diseases and parasites.	2		No	No	0.0
2.5.2. Restore biological habitat components.					
2.5.2.1. Restore food resources.	2		No	No	0.0
2.5.2.2. Control/manage nonnative fishes.	2		No	No	0.0
2.6. Augment or reintroduce razorback suckers in recovery areas.					
2.6.1. Propagate razorback suckers.					
2.6.1.1. Refine propagation, holding, and rearing techniques.	2		Yes	Yes	3.4

Razorback sucker Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
2.6.1.2. Maintain a diversified brood stock.	2		Yes	Yes	3.2
2.6.2. Develop and implement introduction and monitoring activities.					
2.6.2.1. Develop procedures for introduction and monitoring.	2		Yes	No	1.7
2.6.2.2. Reestablish or augment razorback suckers.	2	Stocking programs in Verde and Gila rivers. Focus for additional streams is on upper Colorado River basin.	Yes	No	1.7
2.6.2.3. Monitor reestablishment and augmentation efforts.	2		Yes	Yes	2.5
3. Protect and maintain razorback sucker populations and their habitats.					
3.1. Determine threats to razorback sucker populations.	3		Yes	Yes	3.3
3.2. Monitor and assess the impact of development projects.	3		Yes	No	1.0
3.3. Refine and enforce existing laws and regulations protecting the razorback sucker.					
3.3.1. Review the conservation and enforcement responsibilities appropriate federal agencies and provide input.	3		Yes	No	1.4
3.3.2. Ensure compliance with Section 7 of the Endangered Species Act by all Federal agencies.	3		Yes	No	2.0
3.3.3. Foster better relationships with non-federal agencies and promote more effective state and local government protection.	3		Yes	No	1.0
3.3.4. Assess effectiveness of current regulations/management and draft additional regulations or increase protection and enforcement as needed.	3	Fishing regulations in Verde River.	Yes	No	1.0

Razorback sucker Task	Priority	Accomplishments	Task initiated	Task completed	Subtask score
3.3.5. Discontinue or prevent introductions on nonnative fish species that may have a negative impact on the razorback sucker.	3		Yes	No	1.3
3.3.6. Protect high priority recovery areas.	3		Yes	No	0.8
3.4. Develop and implement cooperative interagency programs to protect and recover the razorback sucker.	3		Yes	No	1.0
4. Develop quantitative recovery gals and a long-term habitat protection strategy.					
4.1. Develop quantitative recovery goals for each recovery area.					
4.1.1. Develop goals for population sizes needed for each recovery area compatible with carrying capacity.	4	Included in supplement.	Yes	No	2.8
4.1.2. Develop habitat restoration or development goals compatible with recovery area needs.	4		No	No	0.0
4.2. Develop quantitative recovery goals for the species.					
4.2.1. Develop quantitative recovery goals for the species.	4	Included in supplement	Yes	No	2.8
4.2.2. Develop ecosystem restoration or development goals.	4		No	No	0.2
5. Promote and encourage improved communication and information dissemination.					
5.1. Develop and conduct workshops to coordinate recovery efforts.	5		Yes	No	1.0
5.2. Conduct nationwide information and education programs.	5		Yes	No	0.8
5.3. Conduct local information and education programs.	5		Yes	No	1.2
5.4. Promote information and education programs within management agencies	5		Yes	No	1.2
5.5. Encourage and support publication of research and other recovery results in the technical literature.	5		Yes	No	1.7

Table 18b. Tasks and priorities identified in recovery supplement and amendment for razorback sucker *Xyrauchen texanus* and accomplishments of tasks (Provisional site specific management and tasks by recovery factor (lower basin), in appendix B in supplement and amendment) within the Gila River basin.

Razorback sucker (amendment) Task	Accomplishments	Task initiated	Task completed	Subtask score
Factor A. Adequate habitat and range for recovered populations provided.				
A 1. Provide flows necessary for all life stages of razorback sucker to support recovered populations, based on demographic criteria.				
A 1.1. Identify, implement, evaluate, and revise (as necessary through adaptive management) flow regimes that are necessary for the establishment and maintenance of razorback sucker populations in the main stem and/or tributaries.		No	No	0.0
A 1.2. Provide flow regimes (as determined under Task A 1.1) that are necessary for all life stages of razorback sucker to support recovered populations in the main stem and/or tributaries.		No	No	0.0
A 2. Minimize entrainment of sub adult and adult razorback sucker in diversion and/or out-take structures.				
A 2.1. Identify measures (e.g., screens, baffles) to minimize entrainment of sub adult and adult razorback sucker at problematic diversion and/or out-take structures (see section 4.1 for discussion on entrainment).		No	No	0.0
A 2.2. Install devices and/or implement other measures (as determined under Task A 2.1) to minimize entrainment.		No	No	0.0
A 3. Provide riverside habitats (e.g., oxbows, depressions, and bottomlands) for all life stages of razorback sucker.				
A 3.1. Identify appropriate riverside sites and assess opportunities for land acquisition or easements.		No	No	0.0
A 3.2. Acquire or procure easements (as determined under Task A 3.1) for riverside sites where determined necessary and feasible.		No	No	0.0
Factor B. Protection from over utilization for commercial.				
B 1. Protect razorback sucker populations from over utilization for commercial, recreational, scientific, or educational purposes.				

Razorback sucker (amendment) Task	Accomplishments	Task initiated	Task completed	Subtask score
B 1.1. Reevaluate and, if necessary, identify actions to ensure adequate protection from over utilization of razorback sucker for commercial, recreational, scientific, or educational purposes; not currently identified as an existing threat (see section 4.2).		No	No	0.0
B 1.2. Implement identified actions (as determined under Task B 1.1) to ensure adequate protection of razorback sucker from over utilization for commercial, recreational, scientific, or educational purposes.		No	No	0.0
Factor C. Adequate protection from diseases and predation.				
C 1. Minimize adverse effects of diseases and parasites on razorback sucker populations.				
C 1.1. Reevaluate and, if necessary, identify actions to minimize adverse effects of diseases and parasites on razorback sucker populations; not currently identified as an existing threat (see sections 4.3.1 and A.12 for discussion of diseases and parasites).		Yes	No	1.0
C 1.2. Implement identified actions (as determined under Task C 1.1) to ensure adequate protection of razorback sucker populations from deleterious diseases and parasites.		No	No	0.0
C 2. Regulate nonnative fish releases and escapement into the main stem, floodplain, and tributaries.				
C 2.1. Develop, implement, evaluate, and revise (as necessary through adaptive management) procedures for stocking and to minimize escapement of nonnative fish species into the main stem, floodplain, and tributaries to minimize negative interactions between nonnative fishes and razorback sucker (see sections 4.3.2 and A.8 for discussion of effects of nonnative fishes).		No	No	0.0
C 2.2. Finalize and implement procedures (as determined under Task C 2.1) for stocking and to minimize escapement of nonnative fish species into the main stem, floodplain, and tributaries to minimize negative interactions between nonnative fishes and razorback sucker.		No	No	0.0
C 3. Control problematic nonnative fishes as needed.				

Razorback sucker (amendment) Task	Accomplishments	Task initiated	Task completed	Subtask score
C 3.1. Develop control programs for problematic nonnative fishes in the main stem, floodplain, and tributaries to identify levels of control that will minimize negative interactions between nonnative fishes and razorback sucker.		No	No	0.0
C 3.2. Implement the identified levels (as determined under Task C 3.1) of nonnative fish control in the main stem, floodplain, and tributaries.		No	No	0.0
Factor D. Adequate existing regulatory mechanisms.				
D 1. Legally protect habitat (see definition of habitat in section 5.1.2) necessary to provide adequate habitat and sufficient range for all life stages of razorback sucker to support recovered populations, based on demographic criteria.				
D 1.1. Determine mechanisms for legal protection of adequate habitat through instream-flow rights, contracts, agreements, or other means (see section 4.4 for discussion of regulatory mechanisms).	Water rights applied for in Verde River and Fossil Creek.	Yes	No	0.8
D 1.2. Implement mechanisms for legal protection of habitat (as determined under Task D 1.1) that are necessary to provide adequate habitat and sufficient range for all life stages of razorback sucker to support recovered populations.		No	No	0.0
D 2. Provide for the long-term management and protection of razorback sucker populations and their habitats.				
D 2.1. Identify elements needed for the development of conservation plans that are necessary to provide for the long-term management and protection of razorback sucker populations; elements of these plans may include (but are not limited to) maintenance of genetic diversity in Lake Mohave, provision of flows for maintenance of adequate habitat conditions for all life stages of razorback sucker, regulation and/or control of nonnative fishes, and monitoring of populations and habitats (see section 4.4 for discussion of need for conservation plans).		No	No	0.0

Razorback sucker (amendment) Task	Accomplishments	Task initiated	Task completed	Subtask score
D 2.2. Develop and implement conservation plans and execute agreements among State agencies, Federal agencies, American Indian tribes, and other interested parties to provide reasonable assurances that conditions needed for recovered razorback sucker populations will be maintained.		No	No	0.0
Factor E. Other natural or manmade factors for which protection has been provided.				
E 1. Other factors	No other factors have been identified as threats (in the lower basin).	No	No	0.0

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