United States Department of the Interior

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In Reply Refer To:
AESO/SE
02-21-90-F-119
02-21-91-F-406
22410-2007-F-0081

May 15, 2008

Memorandum

To: Area Manager, Bureau of Reclamation, Phoenix, Arizona

From: Field Supervisor

Subject: Reinitiated Biological Opinion on Transportation and Delivery of Central Arizona Project Water to the Gila River Basin in Arizona and New Mexico and its Potential to Introduce and Spread Nonindigenous Aquatic Species

Thank you for your request to reinitiate formal consultation with the U.S. Fish and Wildlife Service (Service) under section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), on transportation and delivery of water through the Central Arizona Project (CAP) in the Gila River basin and its potential to introduce and spread nonindigenous aquatic species. This biological opinion (BO) is a reinitiation of the April 17, 2001, biological opinion for the Gila River basin (Gila BO, 2-21-90-F-119) and replaces the draft Biological Opinion of June 11, 1999, on the same subject for the Santa Cruz River (SCR) subbasin (Santa Cruz BO, 2-21-91-F-406). Your request was dated December 22, 2006, and received by us on December 28, 2006. The consultation request for the Santa Cruz has been withdrawn.

You requested reinitiation of consultation to include the SCR subbasin and to consider impacts to the endangered Gila chub (*Gila intermedia*) with designated critical habitat and threatened Chiricahua leopard frog (*Rana chiricahuensis*). Thus, this BO covers changes to the Gila BO, effects to the Gila chub and Chiricahua leopard frog in the entire Gila River basin, and includes the SCR subbasin.

You requested formal consultation on threatened loach minnow (*Tiaroga cobitis*) with designated critical habitat, threatened spikedace (*Meda fulgida*) with designated critical habitat, endangered Gila topminnow (*Poeciliopsis o. occidentalis*), endangered razorback sucker (*Xyrauchen texanus*) with designated critical habitat, Gila chub with designated critical habitat, and Chiricahua leopard frog. You also requested concurrence with your determination that the proposed action may affect, but is not likely to adversely affect, the threatened Apache trout (*Onchyrhynchus apache*), endangered desert pupfish (*Cyprinodon macularius*), threatened Gila trout (*Onchyrhynchus gilae*), and endangered Sonora tiger salamander (*Ambystoma tigrinum* *stebbensi*). We concur with your determinations. The rationale for our concurrences is in Appendix 1.

This reinitiated BO addresses all changes in effects of the action on the endangered Gila topminnow, razorback sucker, Sonora tiger salamander, and desert pupfish, and the threatened spikedace, loach minnow, Apache trout, and Gila trout for the Gila River basin. We will consider effects to the Gila topminnow in the SCR subbasin, as well as effects to the Gila chub and Chiricahua leopard frog for the entire Gila River basin.

This biological opinion is based on the 1994 and 2001 Gila BOs, and the Draft 1999 Santa Cruz BO, which are incorporated here by reference (USFWS 1994, 1999b, 2001c); information used in the preparation of all BOs; the 1994, 1996, 2001, and 2006 biological assessments (BA) (USBR 1994, 1996, 2001, 2006); multiple official correspondence; comments from the applicants and Bureau of Reclamation (Reclamation) on various draft biological opinions; telephone conversations; electronic mail; meetings; data in our files; and other sources of information. References cited in this biological opinion are not a complete bibliography of all references available on the species of concern, the effects of the proposed action, or on other subjects considered in this biological opinion. A complete administrative record of this consultation is on file in this office.

CONSULTATION HISTORY

More detailed information on the topics discussed in this section, including dates of meetings, letters, and memoranda, can be found in the administrative record and is summarized in the biological assessment and previous documents. The consultation history is complex because of the separation of the Gila basin and SCR subbasin for consultation purposes, and their subsequent recombination; the number of times consultation was reinitiated in the Gila basin; the rendering of jeopardy and draft biological opinions; and the length of time that consultation has occurred over the issue of nonindigenous species. Appendix 2 lists the various section 7 consultations that have been done on the CAP.

APPLICANTS

Because of the separate but parallel tracks that consultation on the Gila basin and SCR subbasin took, applicant status was granted by Reclamation at different times for each consultation (Table 1). All the entities listed below are considered applicants for this consultation.

TABLE 1. LIST OF APPLICANTS FOR THIS CONSULTATION AND THE DATES THEY WERE GRANTED APPLICANT STATUS FOR PREVIOUS CONSULTATIONS.

Applicant	Gila Basin	Santa Cruz Subbasin
Central Arizona Water Conservation District	2000	1995
Tucson Water	-	1996
Tohono O’odham Nation	-	1996
Farmer’s Investment Company	-	2000

Gila River Indian Community	2000	-

BIOLOGICAL OPINION

PROPOSED ACTION

The CAP was constructed to provide a long-term, non-groundwater, water source for municipal, industrial, and agricultural (Indian and non-Indian) users in central and southern Arizona. The water provided through the CAP aqueduct is Arizona's remaining entitlement to the flow of the Colorado River. The water is taken from the Colorado River at Lake Havasu and is conveyed 336 miles (540 kilometers) across the state in a series of large, open, concrete-lined aqueducts (Figure 1). Construction began in 1973, and the system was declared substantially completed in 1993 (CAWCD 1995). The proposed action is the same as that described in the Gila BO and the Santa Cruz BO. There have been few changes since then, with the exception of some new recharge projects and water uses, and additional conservation measures.

Figure 1. Map of the Gila River basin, showing major rivers and the route and primary features of the Central Arizona Project canal.

Most details of the CAP aqueduct and its associated features, especially for the Gila River basin exclusive of the SCR subbasin, were provided in Reclamation's various biological assessments (Reclamation 1994, 1996, 2001, 2006) and our various biological opinions (USFWS 1994, 1999b, 2001c), and are not repeated here in detail. The CAP was authorized by Congress in the Colorado River Basin Project Act of 1968 as a system to use Arizona's apportionment of Colorado River water. The purpose is to deliver Colorado River water to municipal, industrial, and agricultural users in central and southern Arizona. There are a series of 14 pumping plants along the canal that raise water to higher elevations. Dozens of turnouts for agricultural, municipal, and industrial uses are present, including several that supply water to groundwater recharge projects within or close to 100-year floodplains.

Santa Cruz River Basin

The part of the CAP considered in the SCR subbasin under this consultation is the 93-mile (150 km) segment that begins at the Pima Lateral turnout near Florence, and ends at the present aqueduct terminus near Pima Mine Road and the Interstate 19 interchange about 15 miles (24 km) south of Tucson (Figure 2). Although water deliveries through the Pima Lateral, Kleck Road, and Casa Grande Extension turnouts were considered in the 1994 Gila BO and its subsequent 2001 revision (USFWS 1994, 2001c), that analysis considered movement of fish through those turnouts directly into the Gila River or into the Santa Cruz River and then downstream into the Gila River. This consultation also considers the movement of those nonindigenous fish and other species through those turnouts upstream into the SCR subbasin, and into the rest of the Gila basin.

Discretionary Reclamation actions for CAP are only a part of a highly complex water delivery system. The system also includes significant State and private actions, and some aspects of CAP include inextricably intertwined Federal and State or private actions and responsibilities (Table 2).

The effects to listed species from the Federal portion of the overall CAP are dependent upon, and cannot be logically analyzed in isolation from, the remainder of the CAP system. Although section 7 consultation applies to Federal actions only, once a Federal action triggers consultation for CAP, then the entire CAP project falls under the purview of the consultation as interrelated or interdependent actions. The environmental baseline of the consultation considers earlier completed Federal actions, such as construction of CAP, earlier State and private activities in relation to CAP, as well as other State, Tribal, local, and private actions already affecting the species or that will occur contemporaneously with the consultation in process. Central Arizona Water Conservation District (CAWCD), a political subdivision of the State, conducts operation and maintenance of the CAP and delivery of water. The operation and maintenance of CAP by CAWCD is done under contract with Reclamation. Thus, operations and maintenance has a federal nexus, and is part of the proposed action under consultation. Delivery of CAP water for M&I entails three-party subcontracts among CAWCD, Reclamation, and the cities. Water deliveries to Tribes, where the Federal government holds the contract, are also a Federal action. However, past water deliveries are part of the environmental baseline. A number of private actions using CAP water, such as some recharge projects, are also interrelated, interdependent, and cumulative to the proposed Federal action. Many recharge projects are likely to have a Federal nexus.

Capacity of the aqueduct in the SCR subbasin is 1,245 cubic feet/second (cfs) (35 cubic meters per second [m^3/sec]) from the Brady Pumping Plant to the Lower Raw Water Impoundment where the flow is divided between two terminus points. The Snyder Hill Pumping Plant, with a capacity of 350 cfs (10 m^3/sec), pumps treated municipal water to the Clearwell Reservoir. The

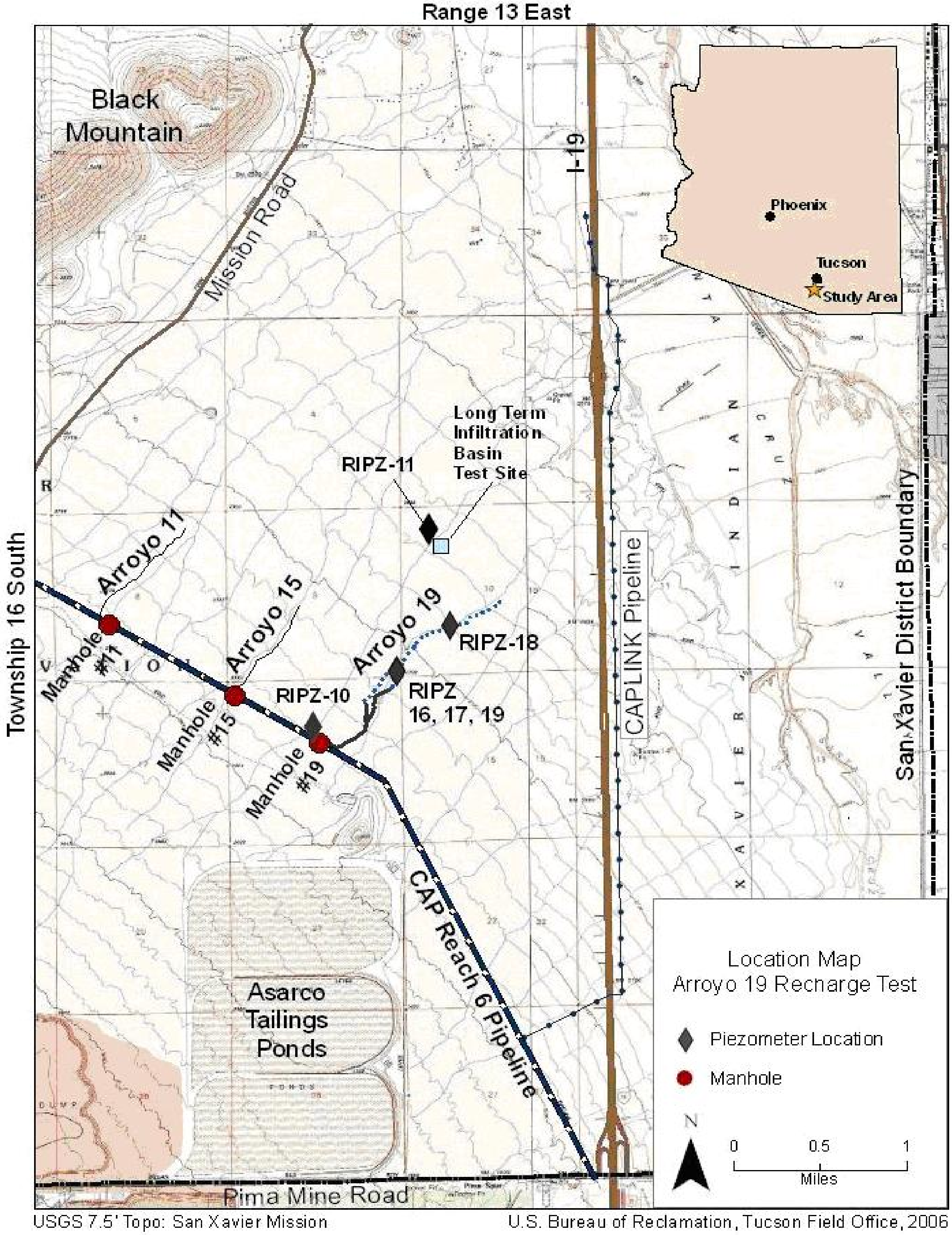

Figure 2. Southern terminus of the Central Arizona Project, south of Tucson, Arizona.

Table 2. Responsible parties for actions related to CAP[1] in Arizona.

ACTION	FEDERAL	STATE	TRIBAL	PRIVATE
Ownership of aqueduct and facilities[2]	Reclamation			
Construction of aqueduct and facilities[2]	Reclamation			
Construction of CAP water storage facilities (not including storage of water taken by contractors/subcontractors) [2]	Reclamation			
Operation and maintenance of aqueduct and facilities[2,3]	Reclamation (pre-1993)	CAWCD (post-1993)[5]		
Allocation and reallocation of CAP water[2]	Reclamation			
Delivery of water to CAWCD (contract holder) [2]	Reclamation			
Delivery of water to Tribes (contract holder) [2]	Reclamation			
Delivery of water to subcontractors[2,3]	Reclamation	CAWCD		
Potential CAP water exchanges[2]	Reclamation			
Construction of new aqueduct features and facilities, including water turnout facilities[2,3]	Reclamation	CAWCD		
Conducting and maintaining cultural and environmental mitigation features/actions [2]	Reclamation			
Stocking of fish and wildlife into local waters which may have CAP water as a source (such as Town Lake) [4]		AGFD		
Regulation of fishing, stocking of fish/wildlife/plants, aquaculture in CAP aqueduct[2,3,4]	Reclamation	CAWCD AGFD ADA		
Regulation of fishing, stocking of fish/wildlife/plants, aquaculture in local waters, which may have CAP water as a source [4]		AGFD ADA		
Use of CAP water[3,4]		CAWCD	X	X
Construction, operation, and maintenance of water use facilities[3,4]				X
Construction, operation, and maintenance of water use facilities on Tribal lands[2,3,4]	Reclamation		X	

Table 2. Responsible parties for actions related to CAP[1] in Arizona.				
ACTION	FEDERAL	STATE	TRIBAL	PRIVATE
Use of effluent and other water made available by CAP water[4]			X	X
Recharge facilities and operation [4]		X	X	X

[1] The party, which has final authority or approval rights to the action. This may not be the entity that actually does the action. The focus here is which types of ownership have discretionary actions that are subject to Endangered Species Act review.
[2] Part of the proposed action; includes actions that are interrelated and interdependent
[3] Part of the environmental baseline
[4] Part of cumulative effects
[5] Under contract with Reclamation

ADA = AZ Dept. of Agriculture
AGFD = AZ Game and Fish Department
CAP = Central AZ Project
CAWCD = Central AZ Water Conservation District

Black Mountain Pumping Plant, with a capacity of 208 cfs (6 m^3/sec), pumps raw CAP water to the terminus that is located just south of Pima Mine Road and just west of Interstate 19. The 14 turnouts along this reach of CAP serve 23 water users (Table 3). Additional turnouts may be constructed, and users may change over the 100-year life of the project. We considered the potential effects of such additional features not currently part of the proposed action in this biological opinion. However, the standard triggers for reinitiation of consultation apply. Besides the users listed in Table 3, deliveries of CAP water may be made on an intermittent or one-time basis, and CAP water may be transferred, leased, or exchanged to other parties.

Substantial agriculture exists in the SCR subbasin, and CAP water for agricultural use is delivered through 13 of the 14 turnouts in the subbasin. Water is conveyed from the main aqueduct via open canals that deliver water to irrigated fields. Some of these canals have direct connections with surface drainages, such as the Florence-Casa Grande Canal to the Gila River. Others do not normally have direct connection, but may have periodic connections through temporary small pumped turnouts for recharge projects, irrigation return flows, excess water sumping, or system cleanouts, or may have unanticipated connections during flooding or when canal components fail along, across, or near streams. Any system components that are located within the channel or floodplain of a stream are considered likely to have some connection to surface flows at some time. This may result from canals or sumps being inundated during high flood events or from siphons, dikes, or canals being washed out, thus allowing mingling of CAP and surface waters.

Agricultural practices vary over space and time, and are expected to change over the 100-year project life. The fields in the Santa Cruz River subbasin primarily use level-basin irrigation, where irrigation return systems are not necessary. However, at times throughout the 100-year project life, agricultural uses could either regularly or under special circumstances place excess irrigation water into the Santa Cruz (either directly or via tributary drainages) or dump excess irrigation water into sumps (ponds) found within the floodplains of the SCR and its tributaries.

Use of CAP agricultural water for aquaculture may result in a number of practices that may

Table 3. Turnouts and allocations for CAP water users[1] south of the Gila River in southern Arizona.

CAP Turnout Name	Entity	Allocation (acre-feet/year)	Status[2]	Class of Allocation[3]
Pima Lateral[4]	Gila River Indian Community Coolidge	311,800 (173,100 CAP; 138,700 settle.) 2,000	2 3	Indian M&I
Kleck Road[4]	Hohokam Irrigation District	Annual excess water contract entitlement based on availability	1	NIA
Casa Grande Extension[4]	Hohokam Irrigation District	Annual excess water contract entitlement based on availability	1	NIA
Santa Rosa	Ak Chin Chui Chu Casa Grande Eloy Maricopa-Stanfield Irrigation & Drainage District Central Arizona Irrigation & Drainage District Arizona State Land Department	75,000 (58,300 CAP, 50,000 settlement)[6] 8,000 (8,000 CAP, settlement[7]) 8,884 2,171 Annual excess water contract entitlement based on availability Annual excess water contract entitlement based on availability 9,026	1 3 3 3 1 1 3	Indian Indian M&I M&I NIA NIA NIA
Central Main	Central Arizona Irrigation and Drainage District	Annual excess water contract entitlement based on availability	1	NIA
South Main	Central Arizona Irrigation and Drainage District	Annual excess water contract entitlement based on availability	1	NIA
Cortaro-Marana	Town of Marana	47	1	M&I
Wildlife	None			
Schuk Toak	Schuk Toak	16,000 (10,800 CAP, 5,200 settlement)	2	Indian
Tucson	Tucson	144,172	1	M&I

Table 3. Turnouts and allocations for CAP water users[1] south of the Gila River in southern Arizona.

CAP Turnout Name	Entity	Allocation (acre-feet/year)	Status[2]	Class of Allocation[3]
	Del Lago (Vail) Water Co.	1,857	3	M&I
	Flowing Wells Irrigation District	4,354	3	M&I
	OroValley Water Utility	10,305	2	M&I
	Metropolitan Water Improvement District	13,460	2	M&I
	Spanish Trail Water Co.	3,037	3	M&I
	Arizona State Land Dept.	14,000	3	M&I
	Avra Cooperative	808	3	M&I
Pascua Yaqui	Pascua Yaqui	500 (500 CAP, settlement[9])	2	Indian
San Xavier 1 and 2	San Xavier	50,000 (27,000 CAP, 23,000 settlement)	2	Indian
Terminus	Green Valley Domestic Water Improvement District	1,900	2	M&I
	Community Water Co. of Green Valley	2,858	2	M&I

[1] Only users that have executed CAP water service contracts are listed. Deliveries to other users may be made on an intermittent or one-time basis.
[2] Status 1 = currently taking CAP water; status 2 = currently planning distribution systems; status 3 = no immediate plans for distribution systems.
[3] M&I = municipal and industrial use, NIA = non-Indian agricultural use.
[4] These users and turnouts were also included in the earlier CAP/Gila biological opinions.
[5] Settlement negotiations currently underway will likely result in the allocation of additional supplies to the Gila River Indian Community.
[6] 33,300 acre-feet of the Ak-Chin CAP allocation has been assigned to the San Carlos Apache Tribe as part of its water rights settlement.
[7] The Chui Chu District of the Tohono O'odham Nation is expected to enter into settlement negotiations.
[8] Share of total State Land Department allocation expected to be used in the Tucson Area.
[9] The Pascua Yaqui Tribe may request to initiate settlement negotiations.

allow perennial or periodic connections between CAP waters and Santa Cruz subbasin surface waters.

Besides normal agriculture deliveries, Central Arizona Irrigation and Drainage District, Maricopa-Stanfield Irrigation and Drainage District, Cortaro-Marana Irrigation District, and BKW Farms have all received CAP water as part of the State of Arizona's in-lieu recharge program (where groundwater use is replaced with CAP water use). Whether and to what extent this program will continue in the future is uncertain. In-lieu groundwater recharge deliveries are not limited to CAP subcontractors and may result in agricultural use of CAP water in areas outside the service areas of CAP subcontractors. Other entities may also receive such CAP deliveries within the 100-year life of the project.

Although an original purpose of CAP was to provide agricultural water, municipal and industrial (M&I) is the fastest growing portion of CAP water use and is expected to become dominant over the 100-year project life. The purpose, mechanisms, and locations of M&I use are quite variable, and are expected to change significantly. At present, there are 14 entities in the Santa Cruz sub-basin M&I allocations of CAP water being considered in this consultation (Table 3), and their areas of water use are located along the SCR from near the mouth upstream to Green Valley, with the greatest use being in the Tucson and Green Valley areas.

Use of M&I water generally falls into two categories:

> 1) Water treated to meet drinking water standards - Treated water has been filtered and disinfected or otherwise rendered completely free of living organisms. In general, use of treated water has no likelihood of transport of nonindigenous species.
>
> 2) Recharging the water to the aquifer – Using shallow constructed basins or natural channels the water is allowed to infiltrate to the groundwater table. The water may then be recovered by nearby wells. Arizona statutes also allow recharge by replacing groundwater used for agriculture with CAP water.

Presently, the City of Tucson and the Northwest Municipal Water Providers (NWMWP; Towns of Oro Valley and Marana, the Metropolitan Domestic Water Improvement District and the Flowing Wells Irrigation District) are all recharging at least a portion of their CAP water allocations. All are developing firm plans for direct use of CAP water for potable purposes. Associated with the direct delivery for the NWMWP is the construction of a 3,000 acre-foot (37,000 cubic decameters [dam^3]) terminal storage reservoir.

Currently, CAP water for M&I purposes in the SCR basin is utilized completely via recharge and recovery. The water is directly recharged either in constructed basins or in natural channels, or as in-lieu recharge for agriculture, as described previously. Table 4 shows existing or proposed recharge projects within the Santa Cruz subbasin and includes recharge projects that are currently permitted by the Arizona Department of Water Resources (ADWR 2006) as well as a variety of other projects for which information was available (RRC 1996, SXD 1999).

Table 4. Tucson Active Management Area underground storage facilities, Arizona.

PROJECT NAME & DESCRIPTION	DURATION	WATER SOURCE	RECHARGE BY	ANNUAL AMOUNT (acre-feet)
Sweetwater Recharge Facilities. Recharge via basins.	07/07/97 to 10/25/2008	effluent	Tucson Water	6,500
Santa Cruz Managed Recharge Project, from Roger Road to Ina Road via streambed.	5/05/00 to 05/31/2019	effluent	Tucson Water & Reclamation	9,307
Lower Santa Cruz Replenishment Project. Recharge via basins.	11/28/03 to 02/28/19	CAP	CAWCD, Robson Communities, AWBA, MDWID, Marana	50,000
Marana High Plains Effluent Recharge Project. Recharge basins.	09/26/05 to 09/26/2007	effluent	CMID	600
Avra Valley Recharge Project via basins.	03/27/98 to 03/27/2018	CAP	CAWCD, MDWID, AWBA, Marana	11,000
Pima Mine Road Recharge Project. Recharge via basins.	05/24/04 to 09/06/2020	CAP	CAWCD, Tucson, AWBA, Green Valley DWID	30,000
Central Avra Valley Storage & Recovery Project. Recharge basins.	10/01/05 to 10/01/2025	CAP	Tucson, AWBA	80,000
South Avra Valley S&RP via basins.	Proposed	CAP	Tucson	60,000
Robson Ranch Quail Creek. Recharge via basins.	12/17/03 to 04/02/2021	effluent	Robson Ranch Quail Creek	2,240
Lower SCR Managed Recharge Project. Via streambed from Ina Road to Trico Road.	11/4/03 to 11/30/2023	effluent	Tucson, MDWID, Oro Valley, Pima Co., Reclamation	43,000
San Xavier District Arroyos*. Recharge via arroyos.	not applicable	CAP	Reclamation, SXD	
Cortaro Marana Irrigation District indirect recharge.	02/17/04 to 04/02/2008	CAP	Spanish Trail, MDWID, Marana, Flowing Wells	20,000
BKW Farms in-lieu recharge.	01/14/04 to 01/31/2009	CAP	Tucson, AWBA, MDWID, CAWCD	16,615

Kai Farms in-lieu recharge -Red Rock in Picacho.	01/14/04 to 12/30/06	CAP	MDWID, CAWCD, Vail WC, Spanish Trail, Oro Valley, Tucson, AWBA	11,231
BKW /Milewide in-lieu recharge.	01/14/04 to 01/31/2009	CAP	CAWCD, Tucson	627
Kai-Avra GSF in-lieu Recharge at AVID.	01/14/04 to 04/02/2008	CAP	MDWID, AWBA, Tucson	12,513
Farmers Investment Company in-lieu recharge.	3/01/04 to 12/31/2016	CAP		22,000
Source: http://www.azwater.gov/dwr/Content/Find_by_Program/Recharge/pdf_files/Semiannual.pdf * information added to ADWR list				

The two types of water being used for artificial recharge are CAP and treated effluent, with about 85 percent coming from CAP. Recharge may be conducted in a variety of locations and designs, including off-channel basins, within natural channels or streams and river floodplains, in constructed wetlands, or in-lieu of groundwater use. To convey the water to the recharge location, pipelines or canals are used. Treated effluent would only be a concern if the quality of the water can sustain fish.

The length of conveyance features can be up to 15 miles, and recharge basins vary from a few acres to several hundreds of acres in size. Recharge basins are typically operated so that they completely dry up periodically, so that the basin bottoms can be disked or scraped to maintain infiltration effectiveness.

In-channel recharge projects involve simply allowing the water to flow down natural drainage channels, such as the SCR or arroyos tributary to the Santa Cruz. Check dams are typically used to slow the flow, decrease erosion, and increase infiltration. Similar to basins, operation of in-channel recharge projects includes intermittent drying of the channel for an extended period to maintain effective infiltration rates. There are two projects using in-channel recharge. Treated effluent is recharged in the SCR from about Prince Road to Trico Road. Several entities accrue credits from this recharge. The San Xavier District (SXD) and Reclamation are operating a CAP recharge project that uses several small arroyos tributary to the SCR (Figure 2). Although not the primary purpose, the SXD Arroyos project may also provide riparian and wildlife enhancement.

Connection between CAP water and Santa Cruz subbasin natural surface waters will rarely occur for recharge projects within stream channels or on floodplains. Recharge flows are curtailed when possible under normal operation, if rainfall or significant natural flows are predicted or expected. Off-channel basins are unlikely to have such connection so long as they are located outside of areas that would be flooded or are protected from flooding, as all are.

Several Indian communities in the action area have executed contracts for CAP water service. In addition, CAP water has been used in settling Indian water rights claims. Most of the water is expected to be used for agriculture, although some will be stored using recharge and restoration of in-stream flows.

The Ak-Chin Indian Community has been receiving irrigation water through the Santa Rosa Canal since 1987 and is expected to continue to do so. While the Chui Chu District of the Tohono O'Odham Nation is also likely to receive its water through the Santa Rosa Canal, definite plans for use await water settlement negotiations. The Pascua Yaqui Tribe has tentative plans to develop part of their reservation west of the CAP Black Mountain Pipeline for agriculture and recharge.

The Tohono O'odham Nation Shuk Toak District has been using their CAP water for agriculture. The SXD is storing some water by recharging in arroyos and using some water for environmental (riparian) restoration projects. They began using some of their CAP water for agriculture in 2007. An in-lieu groundwater savings project with ASARCO was being planned, but is in doubt due to the company filing for bankruptcy.

Interrelated actions are those that are part of a larger action and depend upon that action for their justification, while interdependent actions are those that have no independent utility apart from the action under consultation (50 CFR 402.02). In other words, if those actions would not occur "but for" CAP, they meet the regulatory definition of interrelated and independent actions to CAP and their effects must be considered in this consultation. While a wide variety of private, State, and Tribal actions may qualify as interrelated or interdependent to the CAP, the following discussion is limited to those that would affect the introduction, survival, or spread of nonindigenous aquatic species and their ability to affect listed species.

The relationship among interrelated and interdependent actions, cumulative effects, and indirect project effects is confusing and may overlap. See Appendix 3 for definitions and information on how these various parts of a section 7 analysis relate. Because of the delay in time inherent in indirect effects and the consequent intervening levels of related causation, it may become difficult to separate completely the indirect effects of the Federal action from direct or indirect effects of non-Federal actions that are interrelated and interdependent.

Various uses of CAP water by State, Tribal, and private entities are interrelated and interdependent actions that would not occur but for CAP. Some actions that might occur in the absence of CAP, using water from other sources, may not be interrelated and interdependent, but are cumulative to the Federal action and will be addressed later in the cumulative effects section (see also Appendix 3).

A secondary, but important, interrelated and interdependent action for CAP is the urban, suburban, and small-lot ranchette development that is occurring to accommodate the increasing human population made possible, in part, by CAP water. These actions are an indirect effect of both the interrelated and interdependent CAWCD action of water delivery and the discretionary Federal CAP action (see Appendix 3). Rapid growth is common in areas that receive water through CAP or that have benefited from increased surface or groundwater because of CAP water becoming available elsewhere (Arizona Department of Economic Security 2001).

The increase in human population in the Gila River basin in turn fuels a need for additional water, particularly in areas of CAP "exchanges" where outlying communities exchange or sell their CAP allocations for rights to local water or for funds with which to develop additional surface or groundwater supplies. Three biological opinions on effects of these "exchanges" to listed species have already been issued, one for the upper Gila River in New Mexico, one for the upper Verde River, and one for the middle Verde River (see Appendix 2). However, many of the water development actions expected due to exchange of CAP allocations, and the induced growth that may result, do not involve Federal actions, funds, or permits. In general, those actions would not occur except for the CAP allocation, therefore they are interrelated and interdependent to the CAP and their effects must be considered as part of the analysis of the consultation. To the extent to which some of this water development might occur in the absence of CAP, using water from other sources, those uses may not be interrelated and interdependent, but are cumulative to the Federal CAP action, and will be addressed later in the cumulative effects section.

Human population increases in the basin accelerate demand for use of public lands and for creation of impounded waters for recreation (see U.S. Army Corps of Engineers 1997). Increasing recreation increases the likelihood of human introduction and transport of nonindigenous aquatic species through a variety of mechanisms, causes greater demand for sport fish stocking, and increases live bait use (USFWS 2001a, 2001b). Wetlands, impoundments, and streamflows established for recharge purposes using CAP water may be used to satisfy some of these recreational needs and so play both a direct and an interdependent and interrelated role in this consultation. Other lakes and ponds for water storage or for decorative or recreational use may use CAP water. Construction, operation, and stocking of nonindigenous species into any of these water bodies may be an intricate mix of Federal and non-Federal actions. An example of this is Tempe Town Lake, which was constructed by private and local governmental parties, authorized by the U.S. Army Corps of Engineers under section 404 of the Clean Water Act, filled with CAP water delivered by CAWCD from the federally owned CAP aqueduct, and stocked by Arizona Game and Fish Department (AGFD) using funding, in part, from the Service’s Federal Aid program.

Creation of wetlands or impoundments may be a direct part of the proposed action if the water placed into these is delivered from CAP, as it is in the Granite Reef Underground Storage Project (see USBR 2001). However, some wetlands or impoundments may not directly use CAP water but may still be interrelated and interdependent actions to the proposed CAP action, if they would not occur except to implement CAP deliveries.

Project Changes Since 2001 in the Gila River Basin Exclusive of the SCR Subbasin

The previous consultations on CAP considered operation and maintenance by CAWCD as an interrelated and interdependent action. However, operation and maintenance by CAWCD is done under contract to Reclamation. Thus, it is part of the proposed action, and is analyzed as such in this BO. Operation includes the delivery of water through the main canal and the lateral canal, and operation of the pumping stations. Maintenance includes, but is not limited to, drying and dredging of the canal, sumps, laterals, and pumping stations. Other maintenance actions may include nonindigenous mussel control or repairing various parts of the canal system and the fish barriers.

These changes include addition of several groundwater recharge projects that use CAP water and have potential to establish populations of fish, if only temporarily. The Agua Fria Recharge Project along the Agua Fria River near 99th Avenue and Jomax Road consists of four miles (6 km) of managed in-channel recharge and 100 acres (40 ha) of constructed spreading recharge basins. The permitted capacity of this project is 100,000 acre-feet per year (af/yr)(123,350 dam^3/yr), and it lies completely within the 100-yr floodplain of the Agua Fria River. It became operational in 2002.

The Hieroglyphics Mountain Recharge Project consists of 38 acres (15 ha) of constructed spreading basins outside any 100-yr floodplain, and is permitted to recharge up to 35,000 af/yr (43,000 dam). This project is located where 163rd Avenue intersects the CAP aqueduct, and became operational in 2003.

The Tonopah Desert Recharge Project became operational in 2006, and is located outside any 100-yr floodplain about seven miles northwest of Tonopah. It consists of 206 acres (83 ha) of constructed spreading basins, and is permitted to recharge up to 150,000 af/yr (185,000 dam).

The Superstition Mountains Recharge Project is in the design and permitting phase, and is estimated to begin construction and operation soon. Located near Queen Creek (the stream, not the city) in the far eastern Phoenix valley, it is expected to store up to 85,000 af/yr (105,000 dam) via spreading basins.

Conservation Measures

Conservation measures are actions to benefit or promote the recovery of listed species that are included in the project description as an integral part of the proposed action. They serve to minimize or balance some project effects.

Nonindigenous fishes and other aquatic organisms that reside in Lake Havasu and other system waters can gain access to the CAP aqueduct, where they can be transported, escape, or be moved into surface waters of the Gila River basin via irrigation systems and drains, recharge basins, major surface water interconnections, and people. As described in the various CAP BAs and BOs, conservation measures to minimize this threat or attempt to recover listed fishes in lieu of threat removal include: 1) construction and operation of barriers to upstream fish movement; 2) monitoring of fishes; 3) funding for conservation of native fishes; 4) funding for control and management against nonindigenous fishes; and 5) information and education. In addition, Reclamation has added a conservation measure to fund a Chiricahua leopard frog “head start” program and provide for other conservation actions. Together these provisions address the CAP-mediated nonindigenous aquatic species problem at multiple levels in an attempt to provide a comprehensive treatment. The proposed action includes five conservation measures designed to protect listed species. These are based on reasonable and prudent alternatives developed for the original 1994 BO, which were later modified and incorporated as conservation measures by Reclamation in the 2001 consultation and further modified and proposed by Reclamation here. The measures, as listed below, differ from those described in the June 11, 1999, draft Santa Cruz BO and are organized differently.

Construction and Operation of Barriers to Upstream Fish Movement

Several drop barriers to prevent or hinder upstream movements of nonindigenous fish and other aquatic organisms into high-value native fish and amphibian habitats are completed or proposed for construction. However, they may not be completely effective because some species may be moved above the barriers by humans, birds, and other animals; and under certain circumstances of flooding or damage, the barriers may become ineffective. Sites were selected primarily to protect existing populations of listed fishes or facilitate the repatriation and stocking of native fishes upstream of the barrier. The protection against nonindigenous species these barriers will provide in many instances will also benefit other listed and unlisted native aquatic biota, including leopard frogs, gartersnakes, and mud turtles.

Reclamation or its designate will maintain the barriers as needed over the 100-year life of the CAP. Maintenace of barriers is currently done by CAWCD under contract with Reclamation. Barrier maintenance could include, but is not limited to, installing gabions and riprap, or pouring concrete. Final siting and design of the barriers will be mutually agreed among Reclamation and the Service, in consultation with the Arizona and New Mexico Departments of Game and Fish (AGFD and NMDGF) through the existing CAP Policy and Technical committees that were established to oversee implementation of the CAP conservation measures, and the land owner or manager.

Note that one or two fish barriers on the San Pedro River originally stipulated in the 1994 and 2001 BOs (USFWS 1994, 2001a) were replaced with a conservation measure to construct three San Pedro River tributary barriers (Redfield, Hot Springs, and O'Donnell canyons) after searches for acceptable mainstem sites were exhausted. In addition, a proposal carried through much of the Santa Cruz consultation to construct two fish barriers on the mainstem SCR in Pima County was replaced by a proposal to construct a single mainstem barrier plus three SCR subbasin tributary barriers. Most recently, the proposal for a single mainstem SCR barrier was dropped in favor of extending the period of fund transfers to the Service (see below). Finally, only two of the following three fish barriers proposed for the SCR subbasin are intended to be constructed: Redrock Canyon, Sheehy Spring, or Sonoita Creek (the Cottonwood Spring fish barrier has already been completed). Together these will fulfill Reclamation's commitment to construct three tributary barriers in the SCR subbasin and address the potential effects from CAP water deliveries to those entities listed on Table 3, whether for direct delivery or recharge.

The following is a list of barriers that have been completed or are scheduled for completion as identified in this BO:

a. Redrock Canyon, Santa Cruz Co., AZ—Primary purpose is to protect existing populations of Gila topminnow and Chiricahua leopard frogs, and facilitate replication of the Sheehy Spring population of Gila chub.

b. Sheehy Spring, Santa Cruz Co., AZ—Primary purpose is to protect existing populations of Gila chub and facilitate replication of one of the SCR subbasin populations of Gila topminnow. It may also protect the Huachuca water umbel and Canelo Hills ladies' tresses, two endangered plant species occurring there.

c. Sonoita Creek, Santa Cruz Co., AZ—Primary purpose is to protect existing populations of Gila topminnow and Chiricahua leopard frog, and facilitate replication of one of the SCR subbasin populations of Gila chub.

d. Aravaipa Creek, Pinal Co., AZ (completed)—Primary purpose is to protect existing populations of loach minnow and spikedace.

e. Blue River, Greenlee Co., AZ—Primary purpose is to protect existing populations of loach minnow and Chiricahua leopard frog, and to facilitate replication of the Eagle Creek or New Mexico Gila River populations of spikedace.

f. Bonita Creek, Graham Co., AZ—Primary purpose is to protect existing population of Gila chub and to facilitate replication of Eagle Creek populations of spikedace and loach minnow, and Gila topminnow and desert pupfish.

g. Cottonwood Spring (Sonoita Creek), Santa Cruz Co., AZ (completed)—Primary purpose is to protect existing populations of Gila topminnow and Chiricahua leopard frog. It may also protect populations of Huachuca water umbel and the candidate Huachuca spring snail.

h. Fossil Creek, Yavapai-Gila Co., AZ (completed)—Primary purpose is to protect existing populations of Chiricahua leopard frog and to facilitate replication of the Verde River or Aravaipa Creek population of spikedace and the Aravaipa Creek population of loach minnow, desert pupfish, Gila topminnow, and razorback sucker.

i. Hot Springs Canyon, Cochise Co., AZ—Primary purpose is to protect existing population of Gila chub and to facilitate replication of Aravaipa Creek populations of spikedace and loach minnow.

j. O'Donnell Canyon, Santa Cruz Co., AZ—Primary purpose is to protect existing populations of Gila chub, Gila topminnow, and Chiricahua leopard frog.

k. Redfield Canyon, Cochise Co., AZ—Primary purpose is to protect existing populations of Gila chub and Chiricahua leopard frog and facilitate replication of Aravaipa Creek populations of spikedace and loach minnow.

l. Tonto Creek drainage, Gila Co., AZ (stream not yet identified)—Primary purpose is to protect existing population of headwater chub and facilitate replication of the East Fork White River population of loach minnow and an undetermined population of spikedace. Spring Creek is a potential site for the barrier.

m. Verde River, Yavapai Co., AZ—Primary purpose is to protect existing population of spikedace and facilitate replication of Aravaipa Creek population of loach minnow.

Reclamation will construct a single fish barrier at these sites, of a design similar to those completed on Aravaipa, Sonoita, or Fossil creeks. Siting and design will be subject to agreement between Reclamation and the Service, with appropriate review and input from AGFD, the landowner, and experts on southwestern fishes, hydrology, and nonindigenous species invasions. Reclamation will maintain the barriers in good operating condition for the expected 100-year life of CAP. Management actions upstream of these barriers (e.g., stream renovation, species repatriation) will be the responsibility of the Service or AGFD, but may be funded through the existing Fund Transfer Program. Reclamation or its designate will monitor fish populations upstream of each constructed barrier for a period of five years following construction, unless such monitoring is redundant to that conducted by other agencies. Monitoring is intended to evaluate the success of the barriers in preventing invasions of nonindigenous fishes.

The goal for construction of these barriers is to have them all completed within 15 years from the date of a finalized biological opinion, with a minimum of three to be completed during each of the consecutive five-year periods. However, experience has shown that construction schedules often lapse due to environmental, social, and political controversies that invariably arise when attempting to place fish barriers on dwindling multiple-use surface waters. For these reasons, Reclamation proposes a series of five-year reviews of the progress of fish barrier construction among Reclamation, the Service, AGFD, and NMDGF. Such reviews will evaluate the status of the barrier construction program, assess impacts of potential construction delays to goals of the biological opinion, and determine if rescheduling can be accommodated. Modification of the list of streams on which to construct barriers may also be necessary during these reviews if feasibility studies determine construction is not possible. We assume barrier construction will take the entire 15 years, and analyzed the effects accordingly. Because we considered the impacts from barrier construction, additional consultation on barrier construction may not be needed, unless it is outside the parameters we analyzed or the allowed incidental take.

Three electrical fish barriers have been constructed to hinder or prevent upstream movements of nonindigenous fish and other aquatic organisms from the CAP canal to surface waters of the Gila River basin. These are located on the Salt River Project (SRP) South and Arizona canals immediately downstream from Granite Reef Diversion Dam, and on the San Carlos Irrigation Project (SCIP) Florence-Casa Grande Canal immediately above China Wash. Reclamation or its designate will ensure the continuous operation and maintenance of these barriers throughout the 100-year project life of the CAP. Reports that review the effectiveness of the operation and maintenance of the electrical barriers will be provided to the CAP Policy and Technical committees at 10-year intervals.

Monitoring of Fishes

The purpose of the monitoring is to establish baseline data on the presence and distribution of nonindigenous fishes in targeted stream and canal reaches and to detect changes in species assemblages and distributions. Because of limitations of knowledge and technology and because the largest threat is expected to come from nonindigenous fish, this monitoring is targeted at fish. However, we expect that limited information will also be gathered on distribution of some of the more obvious new nonindigenous amphibians, reptiles, or invertebrates, including when new species appear. Monitoring will be done according to already-established protocols (Clarkson 1996, Allison 2000); any proposed revisions will be subject to review by the CAP Policy and Technical committees. Reclamation will notify the Service, AGFD, and NMDGF of any detection of a nonindigenous fish from an area where it had not previously been found, by telephone or email within five days of the collection. Reports of annual monitoring will be submitted to the Service and interested parties each year, and five-year comprehensive reports that evaluate data trends will be similarly prepared and distributed. The following waters will be monitored annually by Reclamation or it's designate throughout the 100-year life of the CAP, unless other State or Federal programs provide for such monitoring:

- CAP aqueduct;
- Salt River Project Arizona Canal, above and below the electrical barrier;
- Salt River Project South Canal, above and below the electrical barrier;
- Florence-Casa Grande Canal, above and below the electrical barrier;
- Salt River between Stewart Mountain and Granite Reef Diversion dams;
- Gila River between Coolidge and Ashurst-Hayden Diversion dams;
- San Pedro River downstream of the U.S.-Mexico border; and
- Cienega Creek Preserve.

Conservation of Native Fishes Funding

The purpose of this funding is to undertake conservation actions toward protection and recovery of spikedace, loach minnow, Gila topminnow, razorback sucker, Gila chub, and other Gila River basin native fishes by implementing existing and future recovery plans. These funds are not intended to be applied toward Chiricahua leopard frog except as they may provide ancillary benefits. Highest priorities of this fund are to protect existing populations of listed fishes or to replicate wild populations to protected wild sites. These actions are intended to balance threats from the CAP that cannot feasibly be removed or prevented. The most problematic species for CAP mediated impacts are Gila topminnow, spikedace, razorback sucker, and loach minnow. CAP funded activities should concentrate on those four species. However, it is recognized that Reclamation does not bear the entire responsibility for complete recovery of these species, since CAP is not the sole, and may not be the immediate, cause of their deteriorated status.

The threat from nonindigenous species invasion and spread, via CAP, is extremely difficult to control effectively. Although effective for fish, the barriers may not be effective for most invertebrates or plants. Techniques for removing or controlling invading nonindigenous species are expensive, often environmentally damaging, and generally have a low level of success. It is not feasible to achieve full removal of jeopardy with protective measures alone. To deal with that difficulty, funding recovery actions is to implement the recovery plans for those species, thus improving their status throughout their range and making them less vulnerable to serious decline or extinction because of unalleviated adverse effects from CAP.

Reclamation will make available a sum of $275,000 annually for 16 years, beginning in fiscal year 2007 (nine years of funding have already been provided). The addition of $25,000 per year above the amount analyzed in the 1994 and 2001 biological opinions will accommodate conservation needs for new species listings and inflationary pressures against the fund. In addition, Reclamation will continue funding this conservation measure for an additional five years (starting at year 26) at $275,000 annually as partial substitution for any lost recovery potential of the now-abandoned SCR mainstem barrier. Extension of this funding source past 25 years will accommodate some of the continued need for conservation activities.

These monies either will be transferred to us to administer (administrative support costs will be added [currently 22%]), or retained by Reclamation for approved projects that they administer. Reclamation also agrees to reimburse the Service for administrative costs of funds that previously have been transferred but not yet expended. The CAP Policy and Technical committees will mutually agree upon expenditure of these funds. Fund transfers will occur before the end of each Federal fiscal year. We will submit a brief annual report to Reclamation that details expenditures of the fund and how they contributed to recovery of listed fishes in the Gila River basin.

Control and Management Against Nonindigenous Aquatic Species

The purpose of this item is to accomplish control or removal of nonindigenous aquatic species, and to enable research needed to accomplish such actions. The goal of these actions is to directly control threats from CAP introduced or mediated nonindigenous species as well as to enhance the status of affected species through recovery (by nonindigenous management) to compensate for threats from CAP that cannot feasibly be removed or prevented. These funds are not intended to be applied toward Chiricahua leopard frog except as they may provide ancillary benefits. In some cases, it may be appropriate to fund research directed toward improving technologies to control nonindigenous organisms, but the highest priority of this fund is to achieve on-the-ground control. These actions are intended to compensate for threats from the CAP that cannot feasibly be removed or prevented.

Reclamation will make available a sum of $275,000 annually for 16 years, beginning in fiscal year 2007 (nine years of funding have already been provided). The addition of $25,000 per year above the amount determined in the 1994 and 2001 biological opinions will accommodate control activities against nonindigenous species associated with addition of the SCR subbasin to the project area, new species listings, and inflationary pressures against the fund. In addition, Reclamation will continue funding this conservation measure for an additional five years (starting at year 26) at $275,000 annually as partial substitution for any lost nonindigenous control potential of the now-abandoned SCR mainstem barrier. Extension of this funding source past 25 years will accommodate some of the continued need for conservation activities.

These monies will either be transferred to us to administer (administrative support costs will be added), or retained by Reclamation for approved projects that they administer. Reclamation agrees to reimburse us for administrative costs of funds that previously have been transferred but not yet expended. The CAP Policy and Technical committees will jointly agree upon expenditure of these funds. Fund transfers will occur before the end of each Federal fiscal year. We will submit a brief annual report to Reclamation that details expenditures of the fund and how they contributed to nonindigenous aquatic species control and to recovery of listed fishes in the Gila River basin.

Information and Education

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

Chiricahua leopard frog "head start" Program

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

STATUS OF THE SPECIES (Range-wide)

Gila topminnow (*Poeciliopsis o. occidentalis*)

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

Gila topminnow was listed as *Poeciliopsis occidentalis*. The species was later revised to include two subspecies, *P. o. occidentalis* and *P. o. sonoriensis* (Minckley 1969, 1973). *P. o. occidentalis* is known as the Gila topminnow, and *P. o. sonoriensis* is known as the Yaqui topminnow. Publications by Minckley (1999) and Hedrick et al. (2001b), consider Gila topminnow and Yaqui topminnow to be separate species, *P. occidentalis* and *P. sonoriensis*, respectively. This separation is based partly on information presented by Quattro et al. (1996).

The Service has not published a technical correction in the Federal Register to reflect the name changes. Therefore, the taxa listed under the Endangered Species Act are *P. o. occidentalis* and *P. o. sonoriensis*. Both Gila and Yaqui (sub) species receive full protection under the Endangered Species Act, although this taxonomic clarification has not been made.

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

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

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

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

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

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

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

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

Razorback sucker (*Xyrauchen texanus*)

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

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

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

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

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

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

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

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

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

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

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

The razorback sucker is a catostomid fish endemic to the Colorado River basin. Small populations of wild razorback suckers exist in the upper basin in the Green River basin (the Green, Duchesne, White, and Yampa rivers) and the mainstem Colorado River in Colorado and Utah. Wild populations are considered extirpated in the Gunnison River in Colorado and the San Juan River in New Mexico. Aside from a small, undetermined number of wild fish in the Colorado River, most of the upper basin wild population is focused in the Green River basin, and was recently estimated at 108 individuals in 1999 (Bestgen et al. 2002), and hypothesized in that same paper to be less than half that number by 2001. In the lower basin, wild razorback sucker populations are known from Lakes Mead and Mohave. A very few wild individuals may still be found below Lake Mohave to Imperial Dam. The Lake Mead population is estimated at 100 to 200 individuals (Welker and Holden 2003, 2004). The Lake Mohave wild population was estimated at 2,698 in 2002 (Marsh et al. 2003) but has declined to an estimated 218 fish in 2007 (Kesner et al. 2008). Wild populations in Lake Havasu and the river between Parker Dam and Imperial Dam are extremely small, and past stocking activities with unmarked fish, especially in the Parker Dam-Imperial Dam reach, confuse the identification of fish captured there. Recent declines in numbers of wild fish are the result of the old adults that comprise these populations likely dying of old age. None of the populations are confirmed to be self-sustaining, with recent recruitment of wild-bred young only documented in Lake Mead (most recently in Welker and Holden 2004). Some recruitment was assumed for a portion of the middle Green River (Modde et al. 1996), and captures of small razorback suckers in canals below Parker Dam on the Colorado River also represent some recruitment occurring in this area (summarized in USFWS 2001e). Additional monitoring in this area will be required to document recruitment. The recovery goals (USFWS 2002a) contain the most recent life history information on the species. Material in that publication is incorporated by reference.

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

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

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

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

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

3. Protect habitats of these populations from further degradation.

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

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

Spikedace (*Meda fulgida*)

Spikedace was listed as a threatened species in 1986 (51 FR 23769). Critical habitat was designated on March 21, 2007 (72 FR 13356). Critical habitat includes portions of the Verde, middle Gila, San Pedro, San Francisco, Blue, and upper Gila rivers and Eagle, Bonita, Tonto, and Aravaipa creeks and several tributaries of those streams. When we designated critical habitat, we determined the primary constituent elements for spikedace. Constituent elements include those habitat features required for the physiological, behavioral, and ecological needs of the species (72 FR 13356). For spikedace, these include:

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

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

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

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

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

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

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

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

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

8) An abundant aquatic insect food base consisting of mayflies, true flies, caddisflies, stoneflies,

and dragonflies (Anderson 1978, Schreiber 1978, Barber and Minckley 1983, Propst et al. 1986);

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

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

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

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

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

The status of spikedace is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted. A reclassification proposal is pending; however, it is precluded by work on higher priority listing actions (59 FR 35303). The FWS confirmed this decision in 2000 (65 FR 24328). Although spikedace is common in some portions of its highly reduced range, it is uncommon to rare in most. At present, the species is common only in Aravaipa Creek and some parts of the upper Gila River in New Mexico. Populations in the Verde River and Eagle Creek have not been found since 1999 and 1987, respectively, and their status is uncertain (AGFD unpublished data, Marsh et al. 1989, Rinne 1999).

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

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

Loach minnow (*Tiaroga cobitis*)

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

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

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

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

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

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

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

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

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

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

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

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

10) Areas within perennial, interrupted stream courses that are periodically dewatered but that

serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted.

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

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

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

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

The status of loach minnow is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted (59

FR 35303). The FWS confirmed this decision in 2000 (65 FR 24328). A reclassification proposal is pending; however, it is precluded by higher priority listing actions (59 FR 35303). In its highly reduced remaining range, loach minnow varies from common to rare. The species is common only in Aravaipa Creek, the Blue River, and limited portions of the San Francisco, upper Gila and Tularosa Rivers. Remnant populations in the Black, White, and Eagle Creeks are very small and their continued existence is tenuous.

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

1. Protection of existing populations.

2. Monitoring of existing populations.

3. Studies of interactions of loach minnow and nonindigenous fishes.

4. Quantification of habitat and effects of habitat modification.

5. Enhancement of habitats of depleted populations.

6. Reestablishment of loach minnow into its historical range.

7. Quantification of characteristics of a self-sustaining population.

8. Captive propagation.

9. Information and education.

Gila chub (*Gila intermedia*)

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

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

1) Perennial pools, areas of higher velocity between pools, and areas of shallow water among

plants or eddies all found in headwaters, springs, and cienegas, generally of smaller tributaries;

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

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

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

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

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

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

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

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

The San Francisco River has two tributaries with extant populations, Harden Cienega Creek and Dix Creek (Greenlee County). The status of these two populations is unknown, but both are thought to be small. The Agua Fria River has two tributaries with stable-threatened populations, Silver and Sycamore creeks (Yavapai County), as well as two unstable-threatened populations in Little Sycamore Creek and Indian Creek (Yavapai County). In addition, there are two reestablished populations in the Agua Fria drainage, Larry Creek and Lousy Canyon (Yavapai County), for which the population status is unknown. Two tributaries of the Gila River in Arizona have extant populations of Gila chub. Eagle Creek (Graham and Greenlee counties), has an unstable threatened population and Bonita Creek (Graham County), has a stable-threatened population (Weedman et al. 1996, Desert Fishes Team 2003, 70 FR 66664).

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

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

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

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

No recovery plan has been completed, though a recovery outline has (Service files). The recovery outline provides a strategy for the recovery planning effort. It includes processes for developing both short-term emergency recovery actions to prevent further deterioration of the species' status, and longer-term planning for eventual recovery of the species. Development of actions will occur in close coordination with both private and public partners, and with the help of the best experts on the species. We will involve Mexican partners in the planning process, including a representative of the La Comision de Ecologia y Desarollo Sustenable del Estado de Sonora (CEDES) in Hermosillo, Sonora, and other potential partners. Stakeholders will play a crucial role in plan development to ensure that recovery actions can be implemented effectively and in ways that minimize economic and social harm.

Chiricahua leopard frog (*Rana chiricuahuensis*)

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

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

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

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

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

ENVIRONMENTAL BASELINE

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

Action Area

The action area means all potential areas directly or indirectly affected by the Federal action and not merely the immediate area involved in the action. For nonindigenous species issues, the action area is often much larger than the area of the proposed project because of the tremendous and diverse ability of nonindigenous aquatic species to move and be moved throughout, and colonize, large areas of the system. For the proposed project, the action area includes the entire extent of the Gila River basin, including the Santa Cruz subbasin. The action area includes the mainstem Gila River, the mainstem Hassayampa, Agua Fria, Verde, Santa Cruz, Salt, San Francisco, Blue, and San Pedro rivers, and all of their tributary streams in Arizona and New Mexico.

General Environmental Baseline

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

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

Status of the Species (within the Action Area)

Gila topminnow

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

Although the Santa Cruz subbasin contains the best of what remains of Gila topminnow natural populations, the status of the species in the subbasin is poor and declining. At least five populations of Gila topminnow in the Santa Cruz subbasin are known to have been lost since

1940, with the most recent occurring since 1987, and two others potentially lost in 2006. The only four (of 11) existing natural populations free of nonindigenous aquatic animals (Monkey

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

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

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

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

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

Species	Location species found	AGFD releases	Aquatic stocking permits

[1] private sites include aquaculture facilities, gravel pits, golf course ponds, subdivision ponds, public park ponds, private ponds, fish tanks and aquariums, stock ponds
[2] also stocked at sites in southeastern Arizona outside the Santa Cruz River basin
[3] includes those listed as trout”
[4] subspecies *Ambystoma tigrinum mavortium*, which are hybridizing with the Sonora tiger salamander (*A. t. stebbensi*)

TABLE 7. Nonindigenous species found historically in selected southern Arizona waters, and releases by AGFD (AGFD data).											
Species	Arivaca Lake	Bear Grass Tank	Bog Hole Tank	Fagan Tank	Kennedy Park	Parker Canyon Lake	Patagonia Lake	Pena Blanca Lake	Silverbell	Rose Canyon Lake	Lakeside Park
green sunfish	Y++[1]	0	N++	N++	N++	N++	N++	N++[2]	N++	N++	N++
black bullhead	●[1]	---	---	---	---	N++	---	N++[2]	---	---	---
channel catfish	Y++	N++	N++	Y++	Y++	Y++	N++	Y++[2]	Y++	---	Y++
common carp	●	●	●	●	N++	●	●	●	N++	●	N++
goldfish	●	●	●	●	N++	●	●	●	●	●	---
piranha	●	●	●	●	N++	●	●	●	●	●	---
threadfin shad	●	●	●	●	N++	●	N++	--	N++	●	N++
mosquitofish	N++	N++	N++	N++	N++	N++	N++	N++	N++	●	N++
grass carp	●	●	●	●	Y++[3]	●	●	●	Y++[3]	●	---
bluegill sunfish	N++	N++	N++	N++	N++	N++	N++	N++[2]	N++	●	N++
redear sunfish	Y++	N++	N++	Y++	N++	N++	N++	N++	N++	●	---
largemouth bass	Y++	Y++	Y++	Y++	Y++	Y++	Y++	Y++[2]	Y++	---	Y++
rainbow trout	●	●	●	●	Y++	Y++	Y++	Y++	Y++	Y++	Y++
fathead minnow	●	●	●	●	●	●	●	Y■[1]	---1	●	---
flathead catfish	●	●		Y■	●	●	N++	●	●	●	---
black crappie	●	●	N++	●	Y++	●	N++	N++[2]	N++	●	---
tilapia	●		●	●		●	●	●	Y--	●	---

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

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

Cienega Creek

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

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

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

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

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

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

<u>Sonoita Creek</u>

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

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

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

Cottonwood Spring

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

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

Monkey Spring

Monkey Spring is located 1.2 mi (2 km) south of Cottonwood Spring and several hundred feet east of Sonoita Creek. It originates on a sideslope above Monkey Canyon, a tributary of Sonoita Creek. Before diversion, the spring flowed through a marsh then over a travertine terrace that resulted in a waterfall of about 40 ft (12 m) into the canyon (Minckley 1973). In the late 1800's a dam was built across the terrace and the flow diverted into a ditch (see also Chamberlain 1904). The artificial pond later drained when attempts to deepen it resulted in breaking the seal on the bottom. The springhead and a short reach are excluded from livestock grazing. The spring continues to be diverted into a ditch that takes it to the Sonoita Valley for irrigation purposes. Some flow periodically drains into the pond and provides transient Gila topminnow habitat.

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

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

<u>Redrock Canyon</u>

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

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

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

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

Fresno, Coal Mine, and Ash Canyons

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

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

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

Santa Cruz River

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

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

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

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

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

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

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

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

Sharp and Sheehy Springs

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

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

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

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

Heron Spring

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

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

Razorback sucker

Like desert pupfish, razorback sucker was extirpated from the Gila River basin and exists there now only as repatriated populations. There are no records of razorback sucker from the SCR subbasin. The primary stocking efforts are in the Salt and Verde rivers, but razorback sucker have also been stocked into the Gila, Black, Blue, East Verde, and San Francisco rivers and Cherry, Coon, Canyon, Carrizo, Cedar, Tonto, Fossil, Oak, West Clear, Beaver, Sycamore, Eagle, and Bonita creeks (Hendrickson 1993). Survival of these stocked individuals has been very low, and no reproduction has yet been documented (AGFD 1998). Future stocking efforts are expected to focus on the Salt and Verde rivers but may be expanded to include other areas.

The status of the species within the action area is very precarious, since no reproduction from stocked individuals has been documented.

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

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

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

Spikedace and loach minnow

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

In Arizona, loach minnow critical habitat includes portions of the Black River, East Fork Black River, North Fork East Fork Black River, and Boneyard Creek; Aravaipa Creek and its tributaries Deer and Turkey creeks; the San Francisco River, Eagle Creek, and the Blue River and its tributaries, Campbell Blue Creek and Little Blue Creek. In New Mexico, the current designation includes portions of the Blue River; the San Francisco River and its tributary

Whitewater Creek; the Tularosa River and its tributary, Negrito Creek; Campbell Blue Creek; Dry Blue Creek and its tributaries Frieborn and Pace creeks; and the Gila River, including portions of its West, Middle, and East forks.

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

Gila chub

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

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

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

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

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

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

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

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

Chiricahua leopard frog

In the action area in Arizona, the species is extant in the Salt, Verde, Gila, San Pedro, Santa Cruz, river drainages. Within the extant drainages, the species was not found recently in some major tributaries or from river mainstems. Recent surveys suggest the species may be extirpated from the Chiricahua and Galiuro mountains, as well. The Chiricahua leopard frog is known or suspected to have been historically present, and at least in some cases, very abundant (Wright and Wright 1949) in each major southeastern Arizona valley bottom cienega complex. It is thought to be breeding in small numbers in Empire Gulch, but is absent as a breeding species from all others, including Arivaca Cienega, upper Santa Cruz Valley cienegas, Babocomari Cienega, marshy bottoms of the upper San Pedro River, and San Simon Cienega. A small breeding population exists at O'Donnell Creek and cienega, but recruitment to the population appears to be limited due to predation by nonindigenous crayfish, and long-term viability of the population may depend on immigrants Rosen et al. 2002; E. Wallace, pers. comm. 2004). These large, valley bottom cienega complexes may have supported the largest populations in southeastern Arizona, but are now so overrun with nonindigenous predators that they do not presently support the Chiricahua leopard frog in viable numbers. These apparent regional extirpations provide further evidence that the species is disappearing from its range. Once extirpated from a region, natural recolonization of suitable habitats is unlikely to occur in the near future.

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

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

We currently know of 16 likely extant populations of the rim form of Chiricahua leopard frog in the Gila Basin, in Arizona, and 16 likely extant populations in New Mexico. We are aware of about 17 likely extant populations of the southern form in the Gila Basin of Arizona, and no likely extant southern form populations occur in the Gila Basin of New Mexico.

Section 7 Consultation Environmental Baseline

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

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

EFFECTS OF THE ACTION

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

Introduction and spread of nonindigenous species is among the most serious and rapidly growing environmental problems today (Elton 1958, MacDonald et al. 1986, Coblentz 1990, Rosenfeld and Mann 1992, McKnight 1993, Simberloff et al. 1997, Claudi and Leach 2000). It is well documented as a major factor in the decline of southwestern native fishes and ranid frogs, including the six considered in this opinion (Miller 1961, Propst et al. 1986, Propst et al 1988, Carlson and Muth 1989, Miller et al. 1989, Aquatic Nuisance Species Task Force 1994, Sredl and Howland 1994, Cohen and Carlton 1995, Lassuy 1995, Rosen et al. 1995, Clarkson et al. 2005). Minckley (1991:145) succinctly summarized the situation for the aquatic fauna when he wrote, “Native fishes of the American West will not remain on earth without active management, and I argue forcefully that control of nonindigenous warmwater species is the single most important requirement for achieving that goal.” Arizona has one of the highest numbers of introduced fishes of any of the U.S. states (Figure 3).

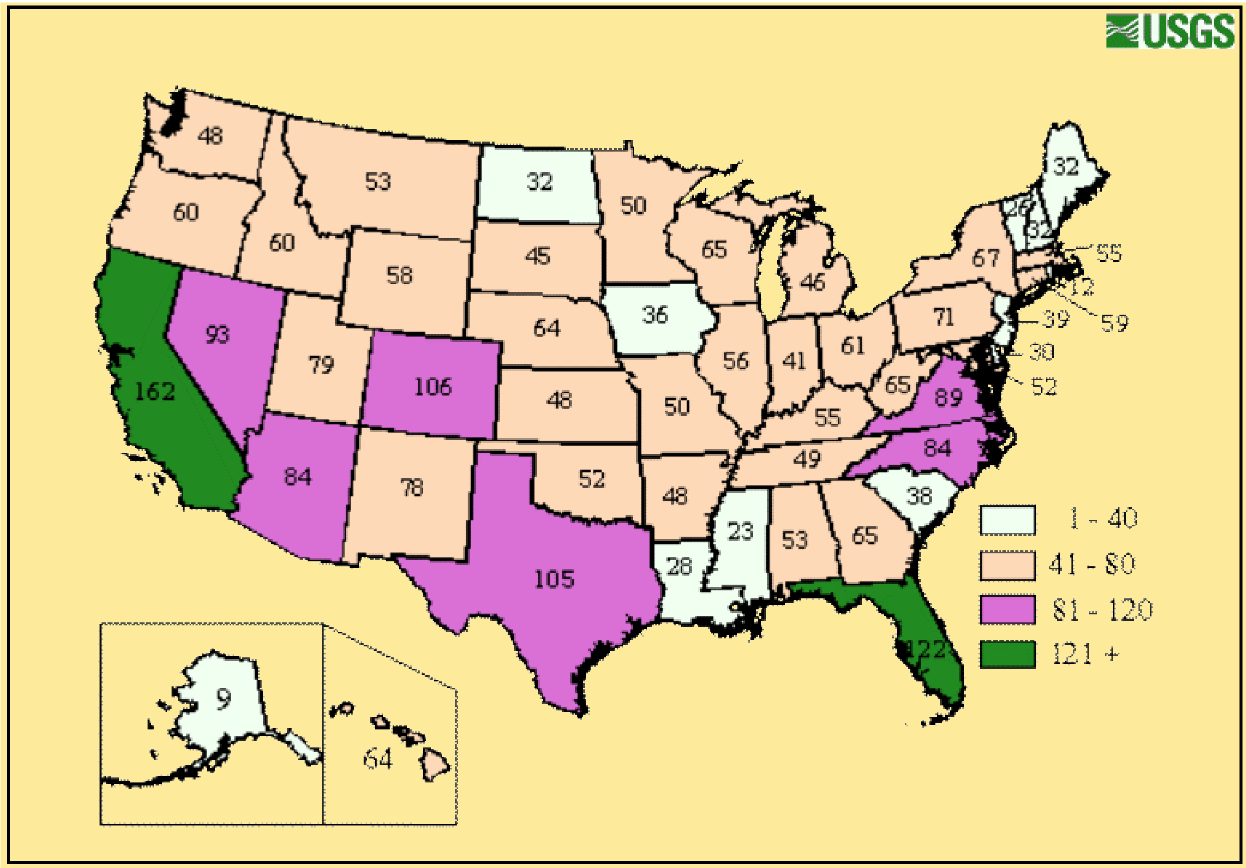

Figure 3. Number of nonindigenous fish species by state (http://cars.er.usgs.gov/posters/nonindigenous/nonind_fish_inland_waters.html).

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

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

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

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

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

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

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

		yellow perch (*Perca flavescens*)	Mettee et al. 1996

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

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

Table 8 cont'd. Transfer of aquatic species via interbasin water transfers: Selected cases.			
Project	Connected Basins	Species Transferred	References
Panama Canal	Atlantic Ocean to Pacific Ocean Pacific Ocean to Atlantic Ocean Caribbean Ocean to Gatun Lake	Atlantic pipefish (*Oostethus brachyurus lineatus*) goby (*Lophogobius cristulatus*) snook (*Centropomus* sp.) tarpon (*Megalops atlanticus*)	Chickering 1930 Rubinoff and Rubinoff 1968 Rubinoff 1970
Suez Canal	Red Sea to Mediterranean Sea Mediterranean Sea to Red Sea	algae - 2 species, plants - 12 species, invertebrates - 72 species, fish - 27 species algae - 1 species, invertebrates - 44 species, fish - 15 species	Por 1978

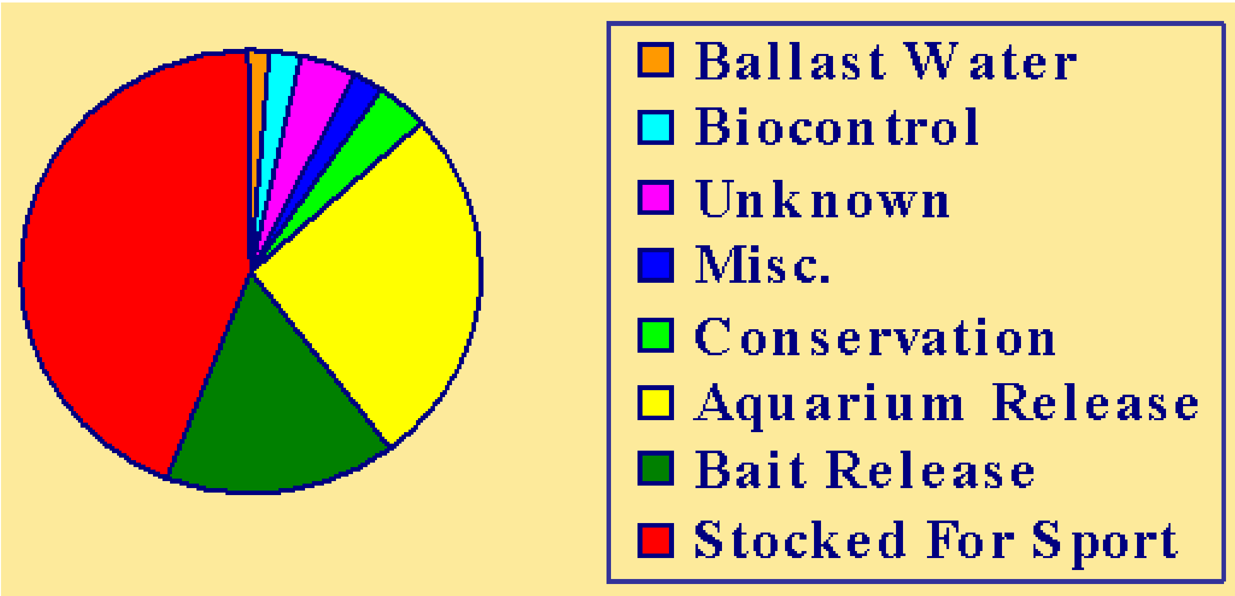

Figure 4. Methods of introduction of nonindigenous fish to the U.S. (http://cars.er.usgs.gov/posters/nonindigenous/nonind_fish_inland_waters.html).

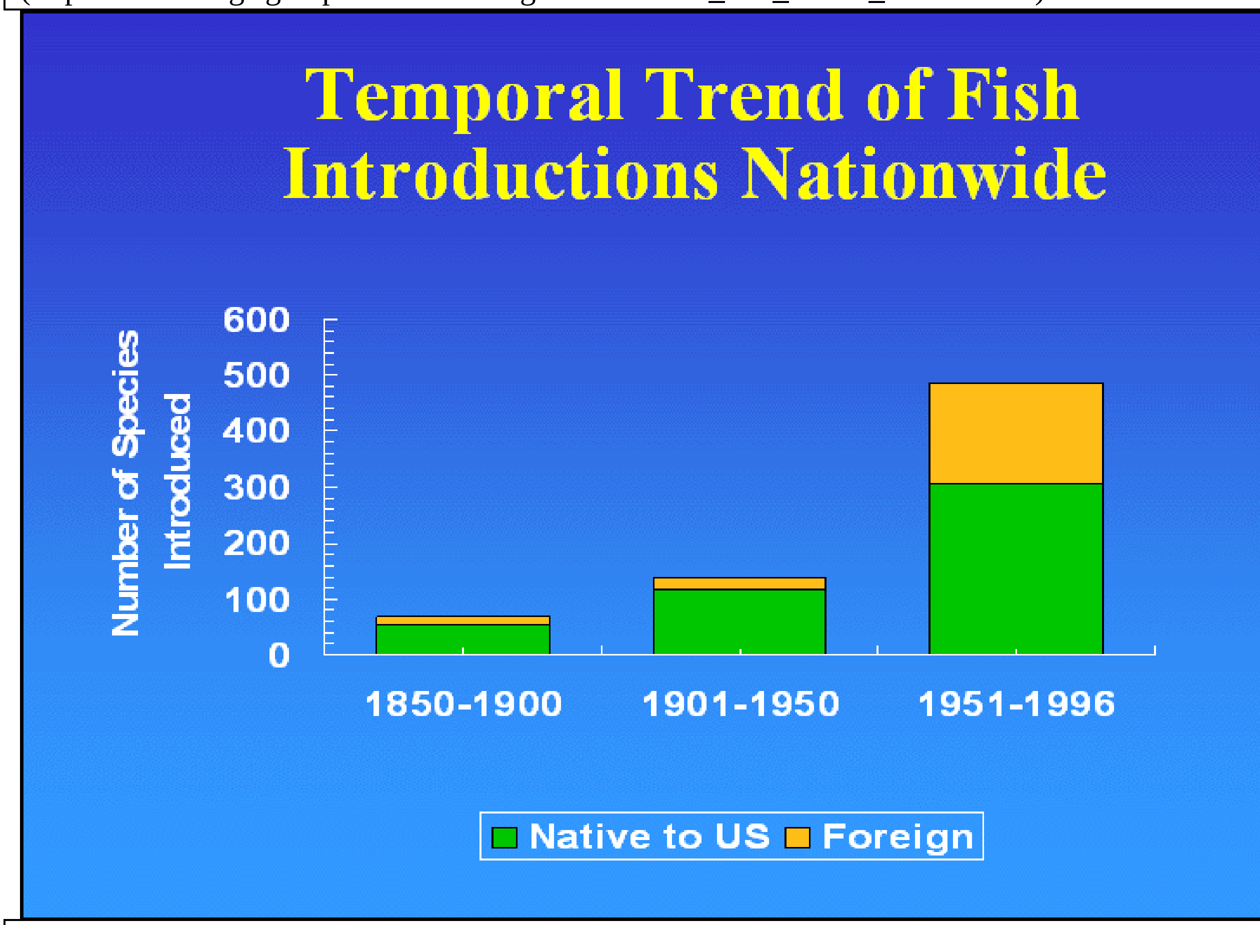

Figure 5. U.S. fish introduction trends (http:\\nas.es.usgs.gov). **"Native to US" includes species which are native to some portion of the United States, and which have been introduced into other areas of the United States that are outside of their historical range**

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

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

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

A panel convened by the Ecological Society of America to consider invasions of nonindigenous species concluded that, although such invasions are a major global problem, it is difficult to identify what species will become invaders and what locations and habitats will be most likely to be invaded (Mack et al. 2000). A great deal of effort has been expended attempting to predict which nonindigenous aquatic species would be successful at colonizing areas opened to invasion due to interbasin water transfers (Grabowski et al. 1984, Balon et al. 1986, USBR 1990, Matter 1991). While these analyses are valuable at identifying concerns, they are limited in their usefulness, because as Laurenson and Hocutt (1985) concluded “prediction of the success of an exotic is difficult." The literature on nonindigenous species invasions is replete with examples of species that succeeded where the best analysis confidently predicted they would not. For example, pink salmon was stocked into the Great Lakes with an expectation that it could not successfully reproduce because it was considered an "obligatory anadromous fish" that could only grow to maturity in the ocean. However, pink salmon became quite successful in the Great Lakes and are the only known population of this species reproducing in fresh waters (Kwain and Lawrie 1981). Grass carp were stocked into many areas in North America after analyses predicted they were unlikely to reproduce. However, there is now documented reproduction in several parts of the Mississippi basin and independent Gulf of Mexico drainages (Brown and Coon 1991, Howells 1994, Raibley et al. 1995), and migrating grass carp have been documented in the Columbia River (Loch and Bonar 1999). Striped bass were not expected to reproduce in Lake Mead, but did so prolifically (Minckley 1991).

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

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

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

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

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

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

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

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

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

Table 9. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal (bold face common name indicates the species has been found in the Tucson reach of CAP). ND = no date for report.			
SPECIES	CAP aqueduct[7]	CAP aqueduct[8]	SRP and F-CG Canals[9]
threadfin shad (*Dorosoma petenense*)	X	X	X
rainbow trout (*Oncorhynchus mykiss*)			X
brook trout (*Salvelinus fontinalis*)			X
common carp (*Cyprinus carpio*)	X	X	X
grass carp (*Ctenopharyngodon idella*)		X	X
grass carp X bighead carp hybrid (*C. idella* X *Aristichthys nobilis*)			X
goldfish (*Carassius auratus*)	X	X	X
red shiner (*Cyprinella lutrensis*)	X	X	X
beautiful shiner (*Cyprinella formosa*)			X
fathead minnow (*Pimephales promelas*)			X
Rio Grande leopard frog (*Rana berlandieri*)			X
bullfrog (*Rana catesbeiana*)			X
spiny softshell (*Trionyx spinifera*)		X	X
red-eared slider (*Trachemys scripta*)			X
longfin dace[1] (*Agosia chrysogaster*)			X
roundtail chub[1] (*Gila robusta*)			X
bigmouth buffalo (*Ictiobus cyprinellus*)			X
desert sucker[1] (*Catostomus* [*Pantosteus*] *clarki*)	X		X
Sonora sucker[1] (*Catostomus insignis*)	X		X
razorback sucker[1] (*Xyrauchen texanus*)	X	X[3]	
flathead catfish (*Pylodictus olivaris*)	X	X[4]	X
channel catfish (*Ictalurus punctatus*)	X	X	X
yellow bullhead (*Ameiurus natalis*)	X	X	X
black bullhead (*Ameiurus melas*)		X	X
mosquitofish (*Gambusia affinis*)	X		X
sailfin molly (*Poecilia latipinna*)			X
shortfin molly (*Poecilia mexicana*)			X

guppy (*Poecilia reticulata*)			X

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

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

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

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

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

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

Operations and Maintenance

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

Effects of Nonindigenous Aquatic Species to the Species Under Consultation

The effects of CAP to the six listed species is additive to the already highly deteriorated environmental baseline of the Gila River basin aquatic ecosystem. The status of the six species is poor and declining, with the long-term prospects for conservation problematic. Remaining occupied habitats are highly altered, making many of them conducive to colonization by nonindigenous species. Many of the former habitats of the six listed species are occupied by nonindigenous species to the exclusion of native species. Unless nonindigenous aquatic species can be controlled and further incursions prevented, recovery is not likely for any of these species, and their continued existence may be in peril.

Nonindigenous aquatic species include fishes, aquatic and semi-aquatic mammals, reptiles, amphibians, crustaceans, molluscs (snails and clams), insects, zoo- and phytoplankton, parasites, disease organisms, algae, and aquatic and riparian vascular plants. They may affect native fish and other aquatic fauna, including the species considered in this opinion, through predation (Meffe et al. 1983, Meffe 1985, Marsh and Brooks 1989, Propst et al. 1992, Rosen et al. 1995, Rosen and Schwalbe 2002, Rinne 1999), competition (Schoenherr 1974, Baltz and Moyle 1993, Lydeard and Belk 1993, Douglas et al. 1994), aggression (Meffe 1984, Dean 1987), habitat disruption (Hurlbert et al. 1972, Ross 1991, Fernandez and Rosen 1996a and b), introduction of diseases and parasites (Sinderman 1993, Clarkson et al. 1997, Robinson et al. 1998, Bradley et al. 2002), and hybridization (Dowling and Childs 1992, Echelle and Echelle 1997). Nonindigenous plants can reduce available habitat with abundant growth (e.g. water cress), potentially cause loss of surface water (e.g. salt cedar), or alter ecosystem dynamics (McKnight 1993, Stromberg and Chew 1997, Lovich and DeGouvenain 1998).

All of the six listed species are highly vulnerable to adverse effects from nonindigenous aquatic species. The Gila basin had a naturally depauperate aquatic fauna, and native aquatic species, including the five fish and one frog considered here, did not evolve with any significant predation or competition (Carlson and Muth 1989, Clarkson and Rorabaugh 1989). This evolutionary history makes them highly vulnerable to adverse effects from nonindigenous species.

All six species are expected to incur serious adverse effects by introduction and spread of nonindigenous aquatic species through the CAP. The degree of vulnerability of populations of these six species and presently unoccupied recovery areas to CAP mediated nonindigenous species is variable. Some, such as those in Aravaipa Creek and in the middle Gila River above Ashurst Hayden Dam are close to, and have direct routes from, the CAP aqueduct, though Aravaipa Creek now has some protection from the two fish barriers there. Others, such as those in the upper Salt River drainage, have a number of dams intervening between that area and the aqueduct and will be affected by CAP only indirectly through nonindigenous spread by bait bucket transport of species made more accessible by CAP, or by species that can move overland and use CAP as a staging area in their colonization efforts. The six species live primarily in medium-to-warmer temperature habitats that are likely to be successfully colonized by nonindigenous aquatic species moving along or being moved from the CAP aqueduct or its related facilities.

There is abundant evidence of the adverse effects of nonindigenous fish on spikedace, loach minnow, Gila topminnow, razorback sucker, Chiricahua leopard frog, and Gila chub. The listing of all of these species was based, in part, on adverse effects of nonindigenous species (USFWS 1984, Minckley and Deacon 1991, 51 FR 23769, 56 FR 54957, 67 FR 40790, 70 FR 66664). Native fishes and frogs of the Colorado River basin, including the Gila River basin, evolved in an aquatic species community that was largely free of predatory and competitive interactions (Carlson and Muth 1989, Minckley and Douglas 1991, Rosen et al. 1994). Many of the species, such as Gila topminnow and Chiricahua leopard frog inhabited areas of the streams in which they were the only aquatic vertebrates present (Minckley 1999, Rosen et al. 1994). Because of this evolutionary history, the native aquatic vertebrates of the Gila River basin are highly susceptible to adverse effects from nonindigenous fishes, most of which evolved in highly complex fish communities where predation and competition were substantial formative forces.

In addition, a recent analysis by Olden et al. (2006) suggests that the suite of ecological niches that nonindigenous fishes may use overlaps those of native fishes of the Colorado River basin. Native species declines are most associated with those nonindigenous species that exhibit the strongest overlaps in life-history strategies or where natives display a “periodic” life-history strategy (generally large-bodied fishes that reproduce in seasonal, periodically suitable environments) that is not well adapted to the altered environments in evidence today. Olden et al. (2006) found that nonindigenous species also tend to occupy vacant niches often provided by human-altered environments or with minimal overlap with native fish life-history strategies.

Spikedace, loach minnow, Gila topminnow, Chiricahua leopard frog, razorback sucker, and Gila chub may all experience adverse effects from amphibians and aquatic reptiles that may invade or spread through CAP. While the CAP aqueduct itself is not suitable habitat for many amphibians and reptiles, it may serve as a movement corridor, and together with various recharge and recreational waters created by CAP water, it may serve as a significant factor in spread of some species. Although bullfrogs are widely spread in the Gila basin, any mechanism that increases their spread is undesirable to native fishes and frogs. Bullfrogs are known to eat fish (Clarkson and DeVos 1986), and at the San Bernardino National Wildlife Refuge stomach samples from bullfrogs have shown that Yaqui topminnow are a common diet item. Gila topminnow are similarly vulnerable, and bullfrogs may be a contributing factor to the serious decline in some topminnow populations, such as Sharp Spring. Adult spikedace, loach minnow, razorback sucker, and Gila chub are less likely to be subject to bullfrog predation, but larvae, small juveniles, and smaller adults are highly vulnerable to bullfrogs, both because of size and because of their use of slower edge and backwaters. Bullfrogs are highly predaceous on Chiricahua leopard frogs, often causing their extirpation from occupied sites (Sredl and Howland 1994, Rosen et al. 1996).

Spiny softshell turtles and sliders are commonly found in the Gila basin and both are carnivores that consume fish on a regular basis (AGFD 2001). Spiny softshell turtles are established in the CAP canal (R. Clarkson, pers. comm., November 2002). Introduced painted turtles and snapping turtles are established in Phoenix area canals (Brennan and Holycross 2006). Use of the aqueduct and CAP created waters for spread of these two and other carnivorous nonindigenous turtles is likely. There are concerns regarding Tempe Town Lake and its potential to increase the likelihood of escape and dispersal of the several varieties of nonindigenous turtles at the Phoenix Zoo (J. Howland, USFWS, pers. comm., 1999).

The Rio Grande leopard frog is another nonindigenous, predatory frog spreading through the Gila basin, and it is likely to use CAP waters and connections to access new areas. This is a large frog, which in New Mexico may actually be replacing bullfrogs in some situations (Degenhardt et al. 1996). It is known to eat other leopard frogs (Platz et al. 1990) and may be expected to consume small fish, such as Gila topminnow, and larval and juvenile spikedace, loach minnow, razorback sucker, and Gila chub.

Parasites and diseases of native fish and frogs may enter the Gila River basin along with nonindigenous frog and fish species. The nonindigenous Asian tapeworm, which recently invaded the Gila River basin, has caused declines of the woundfin in the Virgin River and in the Yaqui topminnow at San Bernardino National Wildlife Refuge (Heckmann et al.1986, USFWS 1997). Asian tapeworm can negatively affect fish through several mechanisms including intestinal disfunction, emaciation, anemia, reduced growth, reduced reproduction, and fatigue (Hoole and Nisan 1994, Mitchell 1994 in Clarkson et al. 1997, Scott and Grizzle 1979). The endangered fountain darter of Texas is being infested by a trematode (unnamed) from an exotic snail, the red-rim melania. The red-rim melania is also present in the Colorado River and has the potential to enter the Gila River system via the CAP aqueduct. Cysts of the trematode infect the gills of the darter. The effect of the cyst on the darter is unknown, but infection levels are very high (Fuller and Brandt 1997). Chytrid fungus is present in bullfrogs and tiger salamanders (Bradley et al. 2002), and is likely spread by them to new sites (Halliday 1998, Bradley et al. 2002, Collins et al. 2003).

The two species of crayfish that already exist in the Gila River basin have had negative impacts on aquatic habitats and on amphibians (Pister 1979, Deacon and Williams 1991, Fernandez and Rosen 1996a and b, Gamradt and Kats 1996, Inman et al. 1998). Many biologists feel that crayfish may have adverse impacts on spikedace and loach minnow, although no mechanism has been demonstrated. However, it is known that large crayfish will capture and eat darters, which are ecologically similar to loach minnow, and there may be food and habitat competition between darters and crayfish (Keller and Moore 2000). Conversely, crayfish make up a large portion of the diet of smallmouth bass and flathead catfish in the Verde River, perhaps benefiting native fishes (Parmley and Brouder 1998), but they may also help maintain those two piscivorous fish at higher populations. It is likely that both a predatory and competitive relationship exist between Gila topminnow and crayfish. In Cave Creek, Gila topminnow and native longfin dace populations crashed coincident with a dramatic upsurge in abundance of northern crayfish (Stefferud 1993, Young and Bettaso 1994). Chiricahua leopard frogs have disappeared from areas where crayfish have invaded (Fernandez and Rosen 1996a and b), and are one of the most serious threats to this frog (USFWS 2007). Enhanced movement throughout the Gila River basin due to the CAP interconnection of subbasins may enable spread of other species. Nonindigenous crayfish invasions have caused substantial concerns in other areas (Lodge et al. 2000). Several species, such as the rusty crayfish, may invade the Gila River basin in the future.

Effects of nonindigenous plants on native aquatic species are more difficult to document than animals because the effects are more indirect. Watercress, which has been spread throughout the entire Gila basin, has significantly modified backwater habitats occupied by Gila topminnow, and larvae and juveniles of other species. However, no data exist that demonstrate negative effects, and potential effects may be obscured by the many other substantial changes to the habitat. Giant salvinia, recently discovered in the Colorado River, has the potential for serious adverse effects to all native aquatic species, but is probably limited by winter cold to lower and warmer sites (Whiteman and Room 1991). It cannot tolerate ice on the water surface, so will not spread to higher sites with cold winters. This plant could easily extirpate Gila topminnow from certain sites by shading out native vegetation and depleting dissolved oxygen in the water (Thomas and Room 1986). Its ability to completely and rapidly cover pooled or low-velocity water in dense mats suggests it would be highly detrimental to Gila topminnow, which feed at the water surface in low-velocity areas, as do larvae and juvenile of native fishes. A plant similar to giant salvinia, the European frog-bit, has been introduced into the northeastern United States and is gradually spreading westward through the Great Lakes (USGS 2001). Like giant salvinia, European frog-bit forms dense floating mats on the surface of quiet waters (Upwellings 2000). Other invasive nonindigenous aquatic plants that have the potential to cover most or the entire water surface, such as water hyacinth and water lettuce (Schmitz et al. 1993), would also likely adversely affect Gila topminnow and larval native fish through interference with feeding patterns and reduction of dissolved oxygen.

Spikedace and loach minnow

Negative impacts to loach minnow and spikedace from nonindigenous species introductions have been and will be significant due to these species' proclivities for and current range in larger, connected stream systems. Adverse effects from a variety of nonindigenous species threaten spikedace and loach minnow. Many of the nonindigenous fish already present (mosquitofish, red shiner, carp, fathead minnow, yellow bullhead, black bullhead, channel catfish, flathead catfish, green sunfish, bluegill, smallmouth bass, and largemouth bass) in spikedace and loach minnow habitats have been implicated in adverse effects to other fish species (Minckley 1973, Moyle and Nichols 1974, Moyle 1976, Karp and Tyus 1990, Lydeard and Belk 1993, Ruppert et al 1993, Tyus and Saunders 2000). These species are all common in various parts of the Gila basin still occupied by spikedace and loach minnow, and their effects may vary from population to population (Propst et al. 1986, Propst et al. 1988, Marsh et al. 1990, Rinne 1991, Douglas et al. 1994, Rinne and Stefferud 1996, Medina and Rinne 1999). While the abundance and distribution of these existing nonindigenous fishes are not expected to be significantly affected by the CAP system, their already existing adverse impacts are great enough that any additions of nonindigenous species could result in serious declines or extirpation of spikedace and loach minnow populations.

For spikedace and loach minnow, the most vulnerable habitats are in the middle Gila River, Aravaipa Creek, and the San Pedro River. These areas are within direct access of potential CAP-derived nonindigenous species moving up the Gila River via its connection with the Florence-Casa Grande Canal, which directly receives CAP water. The electrical barrier on the Florence-

Casa Grande Canal was installed to prevent escapes of nonindigenous species from the canal to the Gila River, but its effectiveness is not 100 percent (Clarkson 2004). The Gila River, being close to the CAP aqueduct, is also vulnerable to bait bucket or accidental transport of species from the aqueduct. Because of the 1994 biological opinion, a paired set of fish barriers was constructed on lower Aravaipa Creek, thus substantially reducing the risk to that habitat. The middle Gila River is designated critical habitat for spikedace and loach minnow, and is poorly protected. The electrical barrier on the Florence-Casa Grande Canal and Ashurst-Hayden Diversion Dam are the only preventative measures between areas of CAP introduction and the listed species' habitats. Neither of those measures are entirely effective. The San Pedro River basin is considered a very important recovery area for those species and is equally vulnerable to CAP mediated nonindigenous fish invasions.

Spikedace and loach minnow habitats above Coolidge Dam are less vulnerable due to the major obstacle to upstream aquatic species movement posed by the dam. However, if nonindigenous species are introduced into the middle Gila River below Coolidge Dam, the likelihood of their being moved above the dam via bait bucket or accidental transport (human, equipment, or animal) becomes substantially greater. Once above Coolidge Dam, there is little to prevent a nonindigenous aquatic species from moving as far upstream as their physiological tolerances permit into the Gila, San Francisco, and Blue rivers, and Bonita Creek. A small dam on lower Eagle Creek, for diversion of water to the Phelps Dodge mine at Morenci, would help inhibit movement up Eagle Creek. Several low-head diversion dams on the Gila are not believed to present any significant long-term obstacle to upstream movement of nonindigenous aquatic species. Any new introductions of nonindigenous species into the Gila River system above Coolidge Dam carry significant potential for serious adverse effects to spikedace and loach minnow. A fish barrier is being constructed on Bonita Creek.

Loach minnow populations in the upper Black and White rivers and critical habitat for both spikedace and loach minnow in the Tonto Creek basin, while highly vulnerable to extirpation or adverse modification from new nonindigenous aquatic species, have a very low likelihood of being affected by nonindigenous aquatic species introduced or spread from CAP. This is due to the presence of two electrical barriers and four major dams on the Salt River between the CAP and those populations. However, heavy recreational use of the Salt River reservoirs has resulted in a number of bait bucket introductions and can be expected to play a part in gradual upstream movement of any nonindigenous species introduced into the lower Salt River by CAP. Heavy boat traffic into Roosevelt Lake, the uppermost of the reservoirs, creates a major risk of movement of species such as zebra mussel and giant salvinia that are likely to be accidentally carried or attached to boats.

The spikedace population and designated critical habitat in the Verde River and several of its tributaries would have only a moderate likelihood of introduction or spread of nonindigenous aquatic species from CAP. The presence of Bartlett and Horseshoe dams between the populations and CAP provides a high level of protection to direct upstream movement of nonindigenous species. However, as the upstream movement of tilapia past Bartlett Dam demonstrates, the recreational use of the two reservoirs creates a moderate to high likelihood that nonindigenous species that access the lower river from a CAP introduction will be moved over the dams by bait bucket transport or by accidental transport.

Gila topminnow

Reestablished Gila topminnow populations tend to be in small and isolated habitats. However, nonindigenous fishes continue to affect wild populations in places like the upper SCR in San Rafael Valley, Sonoita Creek, Sharp Spring, and Redrock Canyon. Introductions of new species over the life of the CAP will degrade existing and recovery habitats for this species. However, renovated streams upstream of constructed fish barriers and in other locations will provide recovery habitat for Gila topminnow.

Many nonindigenous fishes that might enter the Gila River basin through introduction and spread via CAP could have devastating impacts to Gila topminnow, at least in those habitats with connectivity to the rivers and streams of the basin. The pike killifish has been known to extirpate mosquitofish from habitats into which it is introduced (Courtenay and Meffe 1989) and would most certainly do the same to Gila topminnow. Oriental weatherfish may alter habitats and ecosystems and could thrive in soft substrate areas favored by Gila topminnow and desert pupfish (Dill and Cordone 1997).

Gila topminnow have been extirpated from substantial portions of their historical range by nonindigenous fishes. Mosquitofish have been implicated in many losses of Gila topminnow (Schoenherr 1974, Meffe 1984 and 1985, Marsh and Minckley 1990, Minckley 1999). Tilapia and mollies have been implicated in substantial population declines in desert pupfish (Matsui 1981, Schoenherr 1988). Largemouth bass have had adverse effects to Gila topminnow (Stefferud and Stefferud 1994) and caused the extinction of another endemic Gila basin pupfish, the Santa Cruz (= Monkey Springs) pupfish (Minckley 1973).

For Gila topminnow, the most vulnerable reestablished populations are those in the Agua Fria drainage. Extant populations include AD Wash, Larry Creek, Tule Creek, and Lousy Canyon. Populations at Badger Springs, Castle Creek, Cedar Spring, Cow/Humbug Creek, Sheep Spring, Sycamore Creek, and Tule Creek seep, are extirpated and have been identified for augmentation stocking. Most of these habitats are in isolated springs that are very unlikely to be invaded by nonindigenous aquatic species introduced by CAP. However, Tule Creek, Lousy Canyon, Cow/Humbug Creek, and Sycamore Creek all have some level of connectivity to the Agua Fria proper. A fish barrier was built by Reclamation on Tule Creek to inhibit upstream movement by nonindigenous fish moving out of Lake Pleasant. Except at the maximum water level in Lake Pleasant, the barrier should protect this population from direct upstream movement. The barrier is not easily visible or accessible and is not likely to experience bait bucket transport at the barrier site. However, human use in the area is increasing due to heavy recreational development at the lake, thus increasing the potential for bait bucket and accidental transport. Tule Creek is also vulnerable to invasion by semi-aquatic CAP introduced species such as various invertebrates (crayfish, crabs, etc.) and amphibians and reptiles (frogs, turtles, etc.), which may not be stopped by the barrier. Lousy Canyon has a high natural barrier, although some Gila topminnow are present below the barrier and are accessible to upstream movement of CAP introduced species out of Lake Pleasant. The Cow and Humbug Creek complex has no barrier and already is heavily impacted by nonindigenous species. Additional nonindigenous species that might be introduced by CAP into Lake Pleasant are likely to move upstream into Cow and Humbug Creek and preclude use of this habitat by Gila topminnow, barring a barrier and renovation. There are no plans for additional barriers in the Agua Fria drainage.

Two habitats identified for augmentation stocking are also located in the Hassayampa subbasin at Bain Spring and Campbell Flat Spring. The level of risk from CAP introduced nonindigenous species at these sites is low.

Gila topminnow populations are present in the Cave Creek drainage, tributary to the Salt River. Gila topminnow have not been detected at Cave Creek and Seven Springs for several years, but is identified for augmentation stocking. Movement of introduced species into Cave Creek directly from the CAP aqueduct is unlikely. However, the presence of the CAP aqueduct in the area presents some potential for bait bucket or accidental transport into Cave Creek and upstream into the Gila topminnow habitat. In addition, the proximity of the CAP aqueduct to perennial water in Cave Creek increases the likelihood that species, such as frogs and turtles, may use the aqueduct as a staging area in overland movement that may eventually result in their successful colonization of Cave Creek.

The Verde River basin has a number of Gila topminnow populations and recovery habitats. Most of these are isolated springs and have a very low probability of effect from CAP introduced or spread nonindigenous species. However, Lime Creek, which enters Horseshoe Reservoir, and Horse and Red creeks, which enter the river above the reservoir, are periodically connected to the Verde River. The potential for CAP introduced nonindigenous species to reach Horseshoe Reservoir is moderate, and any species reaching there would have open access to Lime Creek and the Gila topminnow population. This could result in loss of this population. The draft Horseshoe-Bartlett Salt River Project Habitat Conservation Plan proposes the construction of a barrier on Lime Creek. The likelihood of such effects to Horse and Red creeks is much less, but there is still some potential for loss of these habitats to nonindigenous species introduced or spread by the CAP. Fossil Creek and the East Verde River, both of which were stocked with Gila topminnow at one time, have been identified for augmentation stocking. Fossil Creek now has a barrier and has been renovated (Weedman et al. 2005, Overby and Overby 2005). The East Verde is normally connected to the Verde River and would be highly vulnerable to any nonindigenous species from CAP that successfully passed both Bartlett and Horseshoe dams.

There are a number of Gila topminnow populations in the Salt River subbasin, particularly the Tonto Creek drainage. Most of these populations are in isolated habitats that are not at risk from nonindigenous species introduced or spread by the CAP. In addition, the presence of the four mainstem dams on the Salt River reduces the risk to Gila topminnow in this subbasin to a low level.

Gila topminnow sites along the middle Gila River (Mescal Warm Springs) and the San Pedro River (Buehman Canyon, Babocomari River, O'Donnell/Canelo Cienega) are at risk from CAP introduced and spread nonindigenous species. Mescal Warm Springs may presently support a population, and it is isolated from the Gila River by a natural barrier. Portions of Buehman Canyon are above a natural barrier and O'Donnell/Canelo Cienega (occupied) and the Babocomari River have several small diversion dams between them and invading species from the CAP that would substantially lower the likelihood of species reaching those sites. There is one desert pupfish population at the Boyce-Thompson Arboretum in an impoundment just off

Queen Creek. The distance from the Gila River and the impoundment dam make the risk to this population from CAP mediated nonindigenous species low. The controlled situation at the admission-required Arboretum should help prevent bait bucket transfers, however bait bucket releases have occurred several times, including fathead minnow that are presently in the pond.

Above Coolidge Dam on the Gila River, there are several occupied, or formerly occupied and identified for augmentation, Gila topminnow habitats at Cold Springs Seep, Big Spring, Green Tanks, Howard Well, Martin Well, and Redrock Wildlife Area. Of these, only Redrock Wildlife Area has sufficient connection to the Gila River to present a significant risk from nonindigenous aquatic species that may move up the river from the CAP. However, the three small spring sites at the Bylas Springs complex are natural remnant populations of Gila topminnow and are the only known remaining stock from the entire Gila basin outside of the Santa Cruz subbasin. As such, their survival is critical. The three springs in the Bylas complex are all located on the edge of the Gila River floodplain just shortly upstream of San Carlos Reservoir. They are highly vulnerable to invasion by nonindigenous species from the river. Although there are small fish barriers on these systems, those barriers are intended to exclude primarily mosquitofish and may not be high enough to exclude other fish. They will also not protect Bylas Springs against CAP mediated nonindigenous species such as crayfish, frogs, turtles, and other species that can move overland, or species such as giant salvinia that might be moved overland by other species. Any additional nonindigenous species introduced into the Gila River in this area, whether through CAP or other means, represent a serious risk of extirpation for the Bylas Springs topminnow populations. Bylas Springs has been invaded multiple times by mosquitofish (Marsh and Minckley 1990, Voeltz and Bettaso 2003).

Except for the Bylas Springs complex, all remaining natural populations of Gila topminnow are in the SCR subbasin and are subject to threat from the introduction and spread of nonindigenous aquatic species via CAP. Predation by many nonindigenous species already occurs, and new predatory species are expected to increase adverse effects to Gila topminnow. It is also highly vulnerable to competition from nonindigenous species. Remaining habitats are generally very small and moderately to highly modified. Competition by introduced species for very limited resources is a substantial threat. Parasites and diseases will enter Gila topminnow habitats along with nonindigenous animals, and some, such as Asian tapeworm, have already infected Yaqui topminnow to the detriment of that subspecies. Human modifications of many Gila topminnow habitats have rendered them only moderately suitable for Gila topminnow. Already under stress because of adverse habitat conditions, any additional stresses to Gila topminnow, such as increased predation, competition, harassment, diseases, or habitat alteration by nonindigenous species is highly significant.

Gila topminnow habitats in the SCR mainstem and Sonoita Creek are the most likely to experience direct water-to-water connections with CAP or CAP in-lieu waters. Therefore, topminnow populations in those areas are the most likely to be impacted by CAP associated transfers of nonindigenous aquatic species. Depending on yearly precipitation and time of year, the 25 to 30 mi (45-50 km) of the river is often dry between Tucson and the most downstream SCR population of Gila topminnow above Tubac. Several in-channel recharge projects may occur in the SCR downstream of this reach, including one in the Green Valley area, and the Gila topminnow population in the SCR downstream from Nogales is the closest population to those projects. This reach of the SCR is readily accessible to people and is parallel to Interstate 19 and other roads, has several crossings, and several adjacent communities and other dwellings. Thus, the potential for bait-bucket transfer is relatively high, and even with a management program against nonindigenous species, there is still a significant likelihood of CAP-mediated nonindigenous aquatic species invasion. The protection of Santa Cruz tributaries will partially offset the inability to protect the mainstem Santa Cruz upstream of the CAP with a barrier.

The probably extirpated population of Gila topminnow in the upper SCR near Lochiel is the upstream end of the population that occupies the loop of the river in Mexico. Information on river conditions in Mexico is incomplete, but we are unaware of any significant barrier to upstream movement of nonindigenous aquatic species from the Tucson area into the upper Santa Cruz. Because it is on privately owned land, the San Rafael population is accessible to most people only at one crossing. This was the most upstream of the riverine populations, is already severely stressed by nonindigenous species impacts, and has a high potential for upstream invasion from nonindigenous species. Longfin dace were found in the river at the US-Mexico border in 2007, for the first time in four years (AGFD and Service files). It is possible these longfin dace came from a population in the river five miles downstream in Mexico.

Alongside the upper SCR lie the Gila topminnow populations of Sharp and Heron springs. The only barrier to nonindigenous aquatic species movement out of the river into Sharp Spring is a short stretch that is dry except during floods. Nonindigenous species moving upstream along the SCR would eventually reach Sharp Spring. The spring is very vulnerable to additional nonindigenous species incursion. Until recently it was privately owned and did not receive much use from people. However, it now belongs to Arizona State Parks Department, and because it is only a short walk from the road, human use and therefore the probability of bait bucket introductions, is expected to increase. As the only remaining Gila topminnow population in a true cienega, as a relatively isolated and pristine habitat, and given its existing threat from mosquitofish and bullfrogs, the level of risk from CAP to Sharp Spring is considered high. Gila topminnow have not been found there since 2002 (Service files), and may have been extirpated by the interconnected effects of mosquitofish and drought. Heron Spring is upstream from a substantial earthen dam impounding a stock tank. Only those nonindigenous aquatics capable of overland or air movement could access the site. Probability of bait-bucket transfer is low because there is limited vehicle access and the spring is not visible from any road. Heron Spring is one of the oldest surviving reestablishment sites, has no mosquitofish, and is considered highly valuable to Gila topminnow survival.

As a habitat that was formerly naturally occupied by Gila topminnow, Sheehy Spring is considered a reestablishment site of extremely high value. The small dam on the spring is not a barrier and did not exclude mosquitofish. Sheehy Spring is vulnerable to invasion by any nonindigenous aquatic species moving up the SCR. Sheehy Spring is also a potential barrier site. Until that barrier is built, impacts from nonindigenous species could occur.

The Sonoita Creek basin contains five Gila topminnow populations. There is perennial flow in Sonoita Creek about 4 mi (7 km) upstream of the Santa Cruz confluence. Gila topminnow are found from the confluence upstream to the Town of Patagonia, except for Patagonia Lake, a recreational fishing reservoir about a third of the way up the drainage. There is no barrier in the lower section of Sonoita Creek to upstream invasion of nonindigenous species from the SCR. This population is already impacted by predation and competition from nonindigenous species, including mosquitofish, whose source is mainly from Patagonia Lake. It is a large population of topminnow and is under stress from a variety of human activities. Human access is moderate and expected to increase. Nonindigenous species invasions from the CAP via the SCR would have a high likelihood of causing extirpation of this Gila topminnow population.

Fresno Canyon is a tributary of lower Sonoita Creek, and it is part of the lower Sonoita Creek complex of natural topminnow populations. A rockfall that is probably a barrier exists in the canyon, and the lower reaches of the canyon flow only during floods. The site is further protected by an ephemeral channel above the barrier. The habitat has been highly impacted by livestock grazing, and there have been several nonindigenous species recorded there. Fencing of the surrounding State Natural Area should greatly reduce grazing. Any new nonindigenous species introductions could extirpate this population. A renovation of Fresno Canyon to remove green sunfish was done in 2007, which should significantly enhance the security of this population, and its tributary population in Coal Mine Canyon.

Coal Mine Canyon, a tributary of Fresno Canyon, also has a natural population of Gila topminnow that was discovered in the 1990s. Coal Mine Canyon empties into Fresno Canyon above the natural barrier on Fresno Canyon. Thus, it would have the same low potential for impacts from nonindigenous species. There is a rough 4-wheel drive road that goes to Coal Mine Spring, where the topminnow mainly reside. However, it is on land owned by AGFD, and behind a locked gate.

Above Patagonia Dam, the risk of upstream invasion from nonindigenous aquatic species decreases. However, as a highly popular recreation area, Patagonia Lake is a prime place for bait-bucket transfers. The population of Gila topminnow in Sonoita Creek above the lake is small and appears to be only barely clinging to existence. The smallness of the creek and the lack of complex habitat keep many of the nonindigenous species in Patagonia Lake from moving upstream into the Gila topminnow habitat, but despite that the species, abundance, and distribution of nonindigenous species above the lake is steadily increasing (H. Blasius, AGFD, pers. comm. November 2001). If this trend continues or if new nonindigenous species more adapted to smaller, flowing habitats are introduced, then this Gila topminnow population could easily be extirpated. The construction of a barrier above Patagonia Lake would restrict nonindigenous species in the lake (both existing and those arriving via the CAP and bait-bucket routes) from moving upstream into upper Sonoita Creek. It would also allow for possible removal of existing nonindigenous species in upper Sonoita Creek as a recovery action. This reach of Sonoita Creek is readily accessible to humans.

Cottonwood Spring is located next to and drains into the floodplain of Sonoita Creek upstream of the Town of Patagonia. There is perennial flow in Sonoita Creek in this area. A barrier to nonindigenous species movement was constructed by Reclamation downstream of this population. The Service, AGFD, The Nature Conservancy, and the private landowner have carried out substantial efforts in the last few years to improve the habitat and population of Gila topminnow at Cottonwood Spring. No mosquitofish or other nonindigenous fish are found here, and it is considered very important to survival of the species to ensure the spring remains free of nonindigenous aquatic species.

Monkey Spring is also a tributary of upper Sonoita Creek, but it is located up a steep drainage and is not in the floodplain. Although it is protected from upstream invasion of nonindigenous species that must swim, Monkey Spring has proved highly vulnerable to nonindigenous predators and has already lost at least one species through that mechanism.

Redrock Canyon, another tributary of the upper Sonoita Creek, until recently supported Gila topminnow in three semi-isolated areas of perennial flow. They are protected from nonindigenous aquatic species invasions by a lower reach that flows only during floods and a natural falls that should be an effective barrier at most flows to fish movement upstream. Two of the core areas of topminnow occupation are above the falls, a third straddles the falls with most of the topminnow being downstream from the falls, and a fourth is located downstream of the falls. Redrock Canyon is one of only two natural populations of Gila topminnow on Federal land and the only one where the watershed is almost entirely under Federal management, and as such has a higher prospect for long-term protection. Nonindigenous fish have been recorded from all areas of the canyon, but only the uppermost area consistently has nonindigenous species in significant numbers. A popular hiking trail in the canyon crosses the creek near the falls and increases the risk of bait-bucket transfer of any species that is moving upstream. The topminnow areas downstream of the falls are at high risk from additional nonindigenous aquatic species moving upstream from Sonoita Creek. Both the planned barrier on Sonoita Creek above Patagonia Lake and the barrier proposed in lower Redrock Canyon would directly restrict upstream fish movement into Redrock Canyon.

Lower Cienega Creek at the Cienega Creek Preserve is above a diversion dam that probably serves as a barrier. This site would have no additional protection by the barriers proposed as part of the CAP project. Movement up the Pantano Wash/Cienega Creek complex in the Tucson metropolitan area would be inhibited by channelization and lack of flow except during floods, but some nonindigenous species movement is likely. The Preserve is readily accessible to humans, but requires a permit from Pima County, and could be used as a transfer point or source for release of nonindigenous species into the upper portion of Cienega Creek. A small natural barrier occurs between the two areas of perennial water, but it would not be 100% effective at stopping all species. Because of upper and lower Cienega Creek's popularity and accessibility, it is a likely candidate for bait-bucket release of nonindigenous aquatic species (Although it is closed to fishing). As the largest Gila topminnow population in existence in the United States and one of only four natural populations free of nonindigenous species, any threat of nonindigenous species incursion is considered of grave threat to the survival of the species in the United States. There is a moderate probability that nonindigenous aquatic species introduced by CAP will spread into the lower reaches of Cienega Creek and then be moved by recreationists over the falls into the Gila topminnow habitat. However, the management against nonindigenous species conservation measure will ameliorate this effect.

In addition to occupied Gila topminnow sites, several previously identified potential reestablishment sites in the Santa Cruz subbasin may be adversely affected by invasion and spread of nonindigenous aquatic species via CAP. These include, but are not limited to, Alambre Tank, Bog Hole, Cinco Ponds, Little Nogales Spring, Nogales Spring, and other sites in the Tucson basin. No comprehensive inventories have been conducted of potential reestablishment sites in the Santa Cruz subbasin. However, many are expected to be stocked with Gila topminnow during the 100-year project life, and may also be adversely affected by nonindigenous species from CAP. Because of scanty information on these sites, it is difficult to assess the vulnerability of specific sites to nonindigenous species from CAP, however, in general the larger and lower-gradient sites are more vulnerable to nonindigenous species invasion. Unfortunately, those characteristics are associated with higher quality Gila topminnow reestablishment sites. As has been discussed, successful reestablishment is considered essential to long-term survival of Gila topminnow.

Over the 100-year life of the CAP, the probability is high that one or more nonindigenous aquatic species will use the CAP as an avenue to colonize habitats now occupied by Gila topminnow and either alone, or in concert with other nonindigenous species or habitat degradation, have major adverse consequences to Gila topminnow. In addition, the probability is also high that one or more nonindigenous aquatic species will be placed via CAP into areas adjacent to Gila topminnow habitat, thereby significantly increasing the probability that people, animals, or other mechanisms will transport it the remaining distance. Together, these direct and indirect effects from CAP carry a substantial likelihood of seriously decreasing the probability of the survival and recovery of Gila topminnow, unless actions are taken to ameliorate the threat.

Razorback sucker

Although razorback sucker repatriations have been attempted with millions of fish and a variety of waters, none have resulted in establishment of sustaining populations (Hendrickson 1993, Marsh et al. 2003, Hyatt 2004, Schooley and Marsh 2007). This species' greatest potential recovery habitat in the basin is in the largest mainstem rivers that also exhibit the highest level of contamination by nonindigenous fishes. Although a planned Verde River fish barrier and renovation could assist recovery efforts for this species in the Gila River basin, a significant change in management direction is needed if recovery is to succeed (Hyatt 2004, Clarkson et al. 2005, Desert Fishes Team 2006).

Razorback sucker exists in the Gila basin only as repatriated, and apparently not yet sustaining, populations. The middle and upper Verde River, the upper Salt River, and the Gila River above Coolidge Dam are designated critical habitat for razorback sucker. The most important of the repatriated populations are in the upper Salt and Verde rivers. As discussed for spikedace and loach minnow, the major dams on both of these rivers reduce the likelihood of invaders from CAP to a low to moderate risk. However, the heavy recreation on the reservoirs is a significant factor in that risk and may be a mechanism that allows a species from CAP to reach the upper Salt or Verde rivers. Razorback sucker were stocked in the Gila River above San Carlos Reservoir, Bonita Creek, and the San Francisco and Blue rivers, and possible recovery habitat exists in the San Pedro River. The status of the populations in these areas is unknown, as no fish have been found in years, and repatriation efforts do not appear successful. The relative accessibility of these areas to CAP introduced or spread nonindigenous species is the same as discussed earlier for spikedace and loach minnow.

In addition to the substantial adverse effects nonindigenous fish have had on remnant natural populations of razorback sucker (Pacey and Marsh 1998, Tyus and Saunders 2000), the repatriation of razorback sucker into the Gila River basin has met with limited success, to a large degree due to nonindigenous fish (Marsh and Brooks 1989, AGFD 1998). Stocking efforts on the upper Salt River have been largely unsuccessful due to heavy predation and dominance of flathead and channel catfishes. Predation on larvae by red shiner has been documented for Colorado squawfish and similar predation by other small nonindigenous species could be expected (Ruppert et al. 1993, Dunsmoor 1995). Nonindigenous species introductions via CAP that might significantly affect razorback sucker would most likely be predatory species or species that alter habitats or carry pathogens. If the incipient spread of white and striped basses via CAP reaches Horseshoe Reservoir, the razorback sucker that use that reservoir could be impacted by predation. Predation on larval and juvenile razorback sucker is a major factor in the decline of reservoir populations on the Colorado River (Minckley et al. 1991, Marsh et al. 2003, Schooley and Marsh 2007), and striped bass are a major part of that predation. Novel species, such as swamp eel, which has invaded Florida, Georgia, and Hawaii, could move through irrigation systems connected to CAP and eventually find its way into backwater habitats used by razorback sucker. Swamp eel is highly predacious and can also move overland and survive drought by burying in wet mud. Several tilapia species have substantial potential for habitat alterations that could adversely affect razorback sucker, particularly in larval and juvenile habitats (Shireman 1984, Dill and Cordone 1997).

Chiricahua leopard frog

Although the Chiricahua leopard frog frequently occupies fishless habitats, we expect it will be negatively impacted by introductions and establishment of nonindigenous organisms, including nonindigenous fishes, American bullfrogs, crayfish, spiny softshell turtle, pond slider, and potentially Rio Grande leopard frogs (*Rana berlandieri*). The swift water, concrete-lined CAP canals are poor habitat for nonindigenous frog species such as bullfrog or Rio Grande leopard frog. No ranid frogs have ever been detected in the CAP since monitoring began in 1986; however, Rio Grande leopard frogs have occasionally been found in concrete-lined canals in southwestern Arizona, southeastern California, and Sonora (Rorabaugh et al. 2002, Rorabaugh and Servoss 2006). But other features of the CAP such as constructed recharge basins are likely to provide better dispersal habitats for nonindigenous amphibians. These habitats may provide stepping stone habitats for the Rio Grande leopard frog and bullfrogs to invade portions of the range of the Chiricahua leopard frog. Also of concern, American bullfrogs and Rio Grande leopard frogs can contract chytridomycosis (Bradley et al. 2002, Rorabaugh 2005) and could carry the disease to Chiricahua leopard frog populations via recharge basins or other CAP aquatic features. Renovated streams upstream of constructed fish barriers within the historical range of the Chiricahua leopard frog should provide recovery habitat for the species, and the conservation fund will provide much needed funds for headstarting and implementation of other recovery actions in the Gila Basin.

Northern populations of the Chiricahua leopard frog along the Mogollon Rim and in the mountains of west-central New Mexico are disjunct from those in southeastern Arizona, southwestern New Mexico, and Mexico. Because these populations are much farther from the CAP and urban population centers, and also above the dams on the Salt and Verde rivers, it is unlikely that they will be seriously impacted by CAP-mediated nonindigenous species. However, many of the populations below the rim do not enjoy the same protections from nonindigenous species that may be moved by the CAP. These southern populations are more likely to be impacted by nonindigenous species moved by the CAP.

Gila chub

Gila chub occupies a variety of aquatic habitats in the basin, some small and relatively isolated, that are less likely to be reached by nonindigenous aquatic species. Other habitats are in larger streams with better connectivity that will increase probabilities of nonindigenous species invasions and their impacts. However, several planned fish barrier projects and stream renovations will directly benefit Gila chub (O'Donnell, Redfield, and Hot Springs canyons, Bonita Creek).

The Gila chub populations in the upper Gila River basin (Turkey Creek [New Mexico], San Carlos River, Blue River [San Carlos drainage], Cienega Creek, Dix Creek, Eagle Creek, and Bonita Creek) would have the same potential for impacts from nonindigenous species as those discussed for the spikedace, Gila topminnow, and loach minnow populations in the upper Gila River basin. The same is also true for the Verde River populations (Walker Creek, Spring Creek, Williamson Valley Wash), as discussed in the razorback sucker, Gila topminnow, and spikedace sections above.

The SCR has four tributaries with extant populations of Gila chub: Sabino Canyon, Romero Canyon, Sheehy Spring, and Cienega Creek. Other locations are being considered for reestablishment. Sabino, Romero, and Cienega are all upstream of the effluent reach of the SCR and the Tucson basin. All three streams have natural or human-constructed barriers, or both, in addition to long stretches of dry stream between the chub-occupied reaches and the SCR. However, all three streams are readily accessible to humans, and thus are susceptible to baitbucket transfer of nonindigenous aquatic species.

The San Pedro River basin has four extant populations in Redfield Canyon, O'Donnell Creek, Hotsprings Canyon/Bass Canyon and near the Babocomari River at T4 Spring. All three streams have natural or human-constructed barriers, or both, in addition to long stretches of dry stream between the chub-occupied reaches and the San Pedro River. However, all locations are readily accessible to humans, and thus are susceptible to baitbucket transfer of nonindigenous aquatic species. The Natural Resource Conservation Service plans barriers at T4 Spring, and existing erosion plugs on O'Donnell Creek will be enhanced.

The Agua Fria River has chub populations at Silver Creek, Little Sycamore Creek, Larry Creek, Lousy Canyon, Indian Creek, and Sycamore Creek. The potential for impacts from nonindigenous aquatic species to Gila chub in the Agua Fria basin are very similar to those described for the Gila topminnow.

Critical Habitat

The PCEs for the razorback sucker, loach minnow, Gila chub, and spikedace are very similar. All four species have PCEs that define critical habitat as having water of sufficient quality and quantity, which includes lack of contaminants; proper levels of dissolved oxygen, nutrients, turbidity, pH, and conductivity; and with a hydrologic regime that meets the needs of each species. Because some of the nonindigenous aquatic species (common carp, tilapia, crayfish, certain plants) are known to affect these elements, nonindigenous species could negatively affect those PCEs dealing with water.

Another PCE common to the four species are provisions for physical habitat. These PCEs cover specific habitat requirements such as pools and riffles, amount of sediment, food supply, sufficient cover, and a healthy, intact riparian vegetation community. Nonindigenous species that alter these habitat characteristics would be problematic for these PCEs. Nonindigenous riparian and aquatic plants can certainly alter intact riparian vegetation, as is evidenced by the widespread impacts of salt cedar (Kerpez and Smith 1987, Stromberg and Chew 1997, Lovich and DeGouvenain 1998). Nonindigenous plants may present more of a problem, since the conservation measures proposed by Reclamation focus more on nonindigenous aquatic vertebrates. The conservation of native fishes funding will address some of the impacts by improving the conservation status of mainly the four listed fish.

Most importantly, areas free of nonindigenous fish are a common component of the PCEs for loach minnow, Gila chub, spikedace, and razorback sucker. Because it is likely that the CAP will move, directly or indirectly, a nonindigenous aquatic species into designated critical habitat, we believe impacts will occur to this PCE component for all four species. It's important to note that some of the areas designated as critical habitat already have multiple nonindigenous species present. Since many of these areas occur in larger aquatic systems, it is unlikely that they feasibly can be treated to remove the existing nonindigenous species, let alone any new ones. In addition, the areas of designated critical habitat that are free, or mostly free, of nonindigenous species, are more likely to stay that way because of their tendency to be further away from the CAP. Because of these existing circumstances and the proposed conservation measures, we do not believe that the effects from the CAP to this PCE rise to a level that significantly adversely affects designated critical habitat for the four species. In addition, the proposed barriers, funding to manage nonindigenous species, and information and education program will ameliorate the likelihood that CAP-mediated nonindigenous species significantly impact critical habitat beyond the degree to which it has already been affected by nonindigenous species.

Several proposed barriers are in designated critical habitat (stream/species):

- O'Donnell Creek – Gila chub;
- Blue River – loach minnow;
- Verde River – spikedace;
- Redfield Canyon – Gila chub;

- Hot Springs Canyon – Gila chub.

If the barriers are constructed in designated critical habitat, there will be effects to the PCEs. Reclamation builds the barriers to minimize impacts to the stream and its hydrology. The barriers should actually enhance the PCE common to all four species, by reducing threats from nonindigenous aquatic species.

Conservation Measures

The conservation measures that Reclamation has included with the proposed action for CAP in the Gila River basin will substantially alleviate threats from introduction and spread of nonindigenous aquatic species via CAP, both directly to the species and to the primary constituent elements of designated critical habitat. The funding of recovery actions will improve the status of the six listed species. Direct threat removal will occur through construction of barriers plus monitoring and management against nonindigenous species, and the information and education program will help alleviate the indirect threat from "bait-bucket" transfers associated with CAP waters and CAP introduced species. However, not all threats can, or will be removed. Significant areas where threats are not ameliorated by the conservation measures include the SCR from Tucson upstream and lower Sonoita Creek. The middle Gila River above Ashurst-Hayden Dam, which is directly connected to the CAP aqueduct through the Florence-Casa Grande Canal, is mostly protected from direct connection by the electrical barriers. The conservation measures also do not effectively ameliorate impacts from nonindigenous aquatic species that may be introduced and spread through CAP that are not fish (i.e. invertebrates, amphibians, turtles, plants, pathogens). Monitoring under the conservation measures is exclusively focused on fish, and the barriers are designed to prevent fish movement, but not necessarily that of other taxa.

Because of this inability to alleviate a portion of the threats from CAP, the conservation measures also include actions for recovery "in-lieu of threat removal." This approach was first used in the 1994 reasonable and prudent alternative to deal with threats from CAP for which there is no known feasible method to remove or ameliorate adverse affects. Recovery in-lieu of threat removal will provide for actions to improve the status of the listed species so that remaining threats are of less consequence to the survival and recovery of those species.

These conservation measures are the result of years of discussion and negotiation to address the impacts of the CAP to listed fish. Each conservation measure was designed to address one part of the nonindigenous aquatic species problem or to enhance the conservation status of native fish. Because each conservation measure is part of an overall strategy designed to address nonindigenous aquatic species, all conservation measures need to be implemented for the strategy to be effective. The jeopardy opinion and the reasonable and prudent alternatives from the 1994 BO have withstood challenges in court.

It must be recognized that although the barriers to upstream fish movement are a major part of the benefits of the conservation measures, if those barriers are not accompanied by appropriate management action, there is the potential that the barriers may result in adverse effects. Barriers fragment populations and prevent upstream emigration (Sloat 1999). Barriers may also have direct and indirect effects, depending on where they are built. Proposed barriers will be placed below or near the downstream end of perennial flow. On streams where nonindigenous species already exist upstream, barriers can, under some circumstances, enhance the likelihood of the nonindigenous species becoming predominant. To ensure benefits from the barriers, in most circumstances they must be accompanied by control of nonindigenous species upstream. Because the nonindigenous species removal and repatriation of native species is outside the authority of Reclamation, the success of the barriers depends heavily on implementation of those management actions by the Service and other entities. The Service is committed to ensuring expeditious and successful completion of those actions, which are necessary to implement the recovery plans for the listed fish considered in this biological opinion. However, the conclusions of this consultation regarding CAP and the extent of Reclamation's responsibility under this consultation are mostly independent of any delays or impediments to implementation or effectiveness of those actions. We assume that all barriers included in the conservation measures will be built within 15 years, regardless of the schedule proposed by Reclamation in the conservation measures.

Barriers

The proposed Redrock Canyon barrier is in the planning stages, in combination with a renovation and fish reestablishment. This barrier will help protect what may still be an existing Gila topminnow population, which is the only natural population on National Forest System land. Chiricahua leopard frogs may also benefit, although the barrier will not be effective against bullfrogs or crayfish that are present nearby. The barrier may also facilitate replication of the Sheehy Spring population of Gila chub. Redrock has mosquitofish, which in combination with drought, likely led to the demise of the topminnow population. Largemouth bass were last observed there in 1995 (Weedman and Young 1997).

The primary purpose of the proposed barrier at Sheehy Spring is to protect existing populations of Gila chub and facilitate replication of one of the SCR subbasin populations of Gila topminnow. It will also facilitate the removal of mosquitofish, which led to the loss of the natural Gila topminnow population there.

The proposed middle Sonoita Creek barrier is intended to protect an existing natural population of Gila topminnow and facilitate replication of one of the SCR subbasin populations of Gila chub. Many nonindigenous fish, in addition to crayfish and bullfrogs, have been found in this reach of Sonoita Creek. The barrier should minimize the movement of nonindigenous fish from Patagonia Lake.

The existing paired barriers on Aravaipa Creek protect existing populations of loach minnow and spikedace, and potentially the Gila topminnow and desert pupfish that have been reestablished on the Aravaipa south rim. Numerous nonindigenous fish have been found in Aravaipa Canyon (Barber and Minckley 1966), including red shiner, which are problematic for spikedace and likely other native fishes.

The primary purpose of the proposed Blue River barrier is to protect existing populations of loach minnow and Chiricahua leopard frogs, and to facilitate replication of the Eagle Creek or New Mexico Gila River populations of spikedace. Numerous nonindigenous fish have been found in the Blue River drainage, and the barrier should minimize further invasions, and allow management against nonindigenous species.

The Bonita Creek proposed barrier is intended to protect an existing population of Gila chub and to facilitate replication of Eagle Creek populations of spikedace and loach minnow. Environmental compliance has been completed for the Bonita Creek barrier and a construction contract has been awarded. This barrier will help protect Bonita Creek from the numerous nonindigenous species in the Gila River.

The existing Cottonwood Spring barrier should protect an existing natural population of Gila topminnow. Mosquitofish have been observed in Sonoita Creek, downstream of Cottonwood Spring.

The purpose of the potential Hot Springs Canyon barrier is to protect an existing population of Gila chub and to facilitate replication of Aravaipa Creek populations of spikedace and loach minnow (completed). Gila topminnow were recently stocked in Hot Springs Canyon, but it is too soon to know if they have established a reproducing population.

The purpose of the proposed O'Donnell Canyon barrier is to protect existing populations of Gila chub, Gila topminnow, and Chiricahua leopard frog. The section of creek above the existing grade control structures was renovated a few years ago, to remove green sunfish and largemouth bass. This stream harbors one of the last populations of Sonora sucker (*Catostomus insignis*) in southeastern Arizona. Green sunfish have recently been found below the grade control structures (Rob Clarkson, Reclamation, pers. comm., March 24, 2008), which will eventually fail unless stabilized.

The primary purpose of the potential Redfield Canyon barrier is to protect an existing populations of Gila chub and facilitate replication of Aravaipa Creek populations of spikedace and loach minnow (completed). Gila topminnow has been reestablished in the Redfield Canyon drainage, but it is too soon to know if they have established a reproducing population. Many nonindigenous species are known downstream in the San Pedro River.

The potential barrier in the Tonto Creek drainage has not yet been definitively identified, but Spring Creek and Rock Creek have been investigated. The primary purpose of the barrier is to protect an existing population of headwater chub and facilitate replication of the East Fork White River population of loach minnow and an undetermined population of spikedace.

The upper Verde River barrier is proposed to protect existing populations of spikedace and facilitate replication of the Aravaipa Creek population of loach minnow. Razorback sucker and other native fishes will also benefit. Renovation is also likely to occur above the barrier.

There will be direct impacts to aquatic organisms during barrier construction, if water and listed species are present during construction. Barrier construction can be a major undertaking, with major impacts at the project site. However, the construction site is only a very small portion of a stream. Indirect effects could include severing populations of listed species, changing local habitat types, and short-term and long-term changes in sediment regimes. Barriers can actually segment fish populations if the barrier has perennial flow below it that can be occupied by the native fish. Movement of fish and genetic material from below the barrier to above the barrier can no longer occur. The impacts of this segmentation should be minor for these reasons:

- Most barriers will be below habitat that is suitable to the six listed species;

- The effects of a segmented population are minor unless the upstream population is small;

- Active management can ameliorate impacts from population segmentation if negative impacts to the population are documented.

- The benefits of protecting the population above the barrier from invasion by nonindigenous species will likely outweigh the negative impacts of segmenting the population of a listed species.

Delays in meeting the stipulated schedule of a minimum of three barriers constructed in each consecutive five-year period may result in small increases in the risk to listed species via nonindigenous species impacts and a lag in the implementation of conservation actions. However, we believe the delay will not significantly change the capability of the conservation measures to remove the threat of jeopardy and adverse modification of critical habitat. Although potential harm to listed species caused by this delay cannot be erased, continued implementation of conservation measures should compensate through application of enhanced recovery actions for the species.

The conservation measures proposed will provide significant assistance in the recovery programs for spikedace and loach minnow, although localized, short-term adverse effects may occur during barrier construction in occupied streams. The benefits will be slightly less for razorback sucker and Gila topminnow, although important recovery actions for both species will occur through the recovery and nonindigenous species management funds, as evidenced by the history of the first years of implementing those funds (Appendix 4). All listed and unlisted native fish in the Gila River basin, especially the desert fishes, will benefit from some recovery actions through these funds.

Even though barriers will afford a major benefit to native fish and frogs, barrier construction and maintenance will adversely affect the six listed species if they were to occur near the barrier. The proposed barrier locations may change, but several of the completed and proposed barriers could have listed species at the site during the life of the barriers or during construction. It is reasonably certain that the construction and maintenance of some of the barriers will occur when one of the six listed species covered by this BO is present. The table below lists the completed and proposed barriers and which of the listed species may be present at that site.

Table 10. Completed and proposed barriers and which of the six listed species may be present at that site or repatriated to the site following barrier construction and stream renovation.

Barrier	Razorback sucker	Gila topminnow	Chiricahua leopard frog	Gila chub	Loach minnow	spikedace
Completed Barriers						
Aravaipa Creek					XXXXX	XXXXX
Cottonwood Spring/Sonoita Creek		XXXXX				
Fossil Creek	XXXXX				XXXXX	XXXXX
Potential Barriers						
Sonoita Creek		XXXXX				
Verde River						XXXXX
Tonto Creek drainage						
Redfield Canyon			XXXXX	XXXXX		
O'Donnell Canyon		XXXXX	XXXXX	XXXXX		
Hot Springs Canyon				XXXXX		
Bonita Creek				XXXXX		
Blue River				XXXXX	XXXXX	XXXXX
Sheehy Spring		XXXXX		XXXXX		
Redrock Canyon		XXXXX	XXXXX			

<u>Funds</u>

The impacts not fully offset by the barriers will be ameliorated by management against nonindigenous species, information and education, conservation of native fishes, and the Chiricahua leopard frog recovery actions. All of these conservation measures will be funded by the Bureau of Reclamation. These conservation measures should ensure that there is not a significant decrease in the numbers, distribution, or reproduction of the six listed species. The conservation measures are expected to provide for the recovery of the species by enabling management actions against nonindigenous species, which should protect important existing populations and provide for the expansion and replication of populations. This funding will also allow control and research activities to occur that should offset most negative effects from CAP facilitated nonindigenous species. The funding provided for recovery actions for both the fish and the Chiricahua leopard frog will not only mitigate for those effects not addressed by the other conservation actions, but it should also enable us to improve the status of all six species. The funding provided for education will create more public support for native aquatic species management and inform the public about issues with nonindigenous species.

The Service is concerned that funding for the conservation measures will largely be spent on spikedace and loach minnow, and larger habitats, to the near exclusion of smaller sites and Gila topminnow. The numbers in Appendix 4 show that, to date, 12 percent of the conservation funds have been spent on Gila topminnow, with eight percent of the recovery funds spent on topminnow. The Gila chub, which was listed in late 2005, has benefited from more spending than the Gila topminnow. Also, loach minnow and spikedace combined account for 57 percent of the funds expended so far. Impacts from CAP-mediated transfer of nonindigenous aquatic species will be problematic in the SCR subbasin. In addition, since most Gila topminnow natural sites are in the Santa Cruz basin and are the cornerstone of Gila topminnow recovery, implementation of the conservation measures must address this issue. The Service believes a minimum of funding for the Gila topminnow and SCR basin is necessary. Of the funding to date that can be directly attributed by basin, two percent of RPA 3 funding and 11 percent of RPA 4 funding have gone to the SCR. Reclamation initially proposed $50,000 annually for recovery actions in the SCR, about 18 percent of the current proposal of $275,000. We requested that $50,000 be funded under RPA 4 for the SCR, also 18 percent of $275,000. Thus, our belief that 10 percent of RPA 3 and RPA 4 be spent on Gila topminnow and the SCR is less than the original proposals by us and Reclamation. While we expect that the funding provided by the two conservation measures will address Gila topminnow in the SCR, we want to ensure that it does. The SCR subbasin is also important for the conservation and recovery of the Chiricahua leopard frog and Gila chub, which also demonstrates the necessity for actions occurring in the Santa Cruz basin to be funded.

Fish Monitoring

The purpose of the monitoring program is to establish baseline data on the presence and distribution of nonindigenous and native fish in the target reaches. Experience from the CAP Gila opinion has shown that it is not possible to detect small to moderate changes in abundance of various species within the fish community. Therefore, the primary goal of this monitoring is to determine presence or absence of nonindigenous species and distribution within the Gila River basin of those present, detect substantial changes in distribution, and detect major changes in the fish community over time. Because of limitations of knowledge and technology and because the largest threat is expected to come from nonindigenous fish, this monitoring is targeted at fish. However, it is expected that limited information will also be gathered on distribution of some of the more obvious new nonindigenous amphibians, plants, reptiles, or invertebrates, including when new species appear. Monitoring is a necessary component of the conservation measures, as it must be done in addition to construction of barriers to identify when management actions against nonindigenous species should be taken.

Information and Education

The purpose of the information and education conservation measure is to increase public awareness of human-aided bait bucket transfers, pet-dumping, and other private avenues of nonnative aquatic species introductions and translocations and to increase awareness of, and support for, conservation of native fishes and their habitats, with emphasis on the problems nonnative aquatic species create for those species. Without an attempt to address the source of many nonindigenous species introductions, people, the other conservation measures are likely to fail. We do not expect this information and education will be able to fix the problem. But this program, in concert with similar programs conducted by other agencies, may help reduce the movement of nonindigenous species.

Conclusion to Effects Analysis

Novel and existing nonindigenous fishes and other aquatic organisms that enter, are transported through, moved by people into or out of, or escape from the CAP canal and enter Gila River basin surface waters via its interconnection points, have potential to move upstream into surface waters occupied by the federally listed species considered here. Nonindigenous species that escape the CAP have the potential to establish populations in surface waters where they further are subject to human-mediated transport to waters inhabited by federally listed species via bait bucket or unintentional transfer. Negative impacts to federally listed species can accrue via predation, competition, or hybridization or through modification of habitat. Nonindigenous species can also harbor exotic parasites and disease that could be transferred to populations of federally listed aquatic organisms.

In summary, the six species addressed here are all highly vulnerable to adverse impacts from nonindigenous aquatic species and already exist under some degree of pressure from nonindigenous predation, competition, disease transmission, or other threats. The habitats of all six species are degraded and are threatened by a wide variety of ongoing or future impacts. The status of the species is poor and declining. The CAP is an interbasin water transfer and will, like most other such transfers, introduce and spread nonindigenous aquatic species. Except for the species already introduced through CAP (striped bass, white bass, Asian clam, quagga mussel), the identity of the species which will invade is not entirely predictable but may include a wide variety of invertebrates, vertebrates, and plants. Sufficient facilities and mechanisms for movement from the CAP into Gila basin surface waters exist to ensure that some nonindigenous species are likely to make that move, either by themselves or with human assistance. Bait bucket transfers of nonindigenous species made more available through CAP are likely to occur. Water bodies created using CAP water will provide increased habitat and colonization staging areas for nonindigenous aquatic species. Some existing populations of spikedace, loach minnow, Gila topminnow, Gila chub, razorback sucker, and Chiricahua leopard frog may be affected up to the level of extirpation, while others may experience little or no effects. Recovery potential for these species may be completely precluded in some areas, including designated critical habitat. These adverse effects mostly are ameliorated by the conservation measures, although there are significant areas where threats cannot be feasibly removed. Recovery in-lieu of threat removal provisions of the conservation measures assist in counteracting those remaining threats.

We believe that the conservation measures will limit or address the impacts from nonindigenous species that may be transported by CAP-mediated avenues to the listed species and their designated critical habitat. Any impacts not limited or addressed by the barriers, management against nonindigenous species fund, and information and education, will be ameliorated by the conservation of native fishes funding, and the funding for Chiricahua leopard frog recovery actions. These conservation measures should, therefore, ensure that there is not a significant decrease in the numbers, distribution, or reproduction of the six listed species. The conservation measures are expected to provide for the recovery of the species by enabling management actions against nonindigenous species, which should protect important existing populations and provide for the expansion and replication of populations.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation following section 7 of the Act.

There are many actions associated with the CAP, including those of CAWCD that are often interrelated or interdependent. Other actions are cumulative. Please refer to Table 2 for a listing of the responsible parties for actions related to the CAP.
Private actions using CAP water are also cumulative to the Federal action involved in CAP. The use of CAP water for agricultural, municipal and industrial, Indian, and recharge purposes may change significantly over the course of the 100-year project life, but is not expected to cease or decrease. Therefore it is a reasonably foreseeable action, the effects of which must be considered in the analysis conducted in this biological opinion. It is also likely that the CAP, in its current or modified form, will continue past the 100-year project life. As with some CAWCD cumulative actions, the private actions directly using CAP water are described as part of the earlier overall project description section of this biological opinion.

Various non-Federal actions in addition to those from direct use of CAP water are also cumulative to the CAP impacts to six listed species. Human population growth in the Gila River basin, particularly in Phoenix and other urban areas, is predicted to occur into the future (Arizona Department of Economic Security 2001) and will place ever greater demands on all natural resources in the basin, especially water. Growth and development will continue to result in changes in watershed condition and watershed function affecting water quality and quantity, riparian vegetation, channel morphology, and flood characteristics. Groundwater pumping in areas such as the upper San Pedro Valley and the Prescott and Chino Valley area threaten the water supply of streams important to spikedace, loach minnow, Gila topminnow, and razorback sucker. As more people live and recreate in the area, opportunities will also increase for nonindigenous aquatic species to enter the basin. Illegal releases of nonindigenous organisms will continue and increase (Aquatic Nuisance Species Task Force 1994, Rosen et al. 1995) as will the demand for stocking of nonindigenous sport fish by the AGFD (65 FR 24328). Use of nonindigenous organisms as pets may also increase, as will illegal release of those organisms (Moore et al. 1976, Shelton and Smitherman 1984, Welcomme 1988).

There are many conservation actions being considered by the AGFD for native fish and frogs. Two important conservation actions are the approved Safe Harbor Agreements for the Chiricahua leopard frog and the topminnow and pupfish. While these two agreements and any other conservation actions taken by AGFD are likely to be federally funded or approved, at least some of them will have no Federal nexus.

That southeastern Arizona and much of the American southwest have experienced serious drought recently is well known. What is known with far less certainty is how long droughts last. State-of-the-art climate science does not yet support multi-year or decade-scale drought predictions. However, instrumental and paleoclimate records from the Southwest indicate that the region has a history of multi-year and multi-decade drought (Hereford et al. 2002, Sheppard et al. 2002, Jacobs et al. 2005). Multi-decade drought in the Southwest is controlled primarily by persistent Pacific Ocean-atmosphere interactions, which have a strong effect on winter precipitation (Brown and Comrie 2004, Schneider and Cornuelle 2005); persistent Atlantic Ocean circulation is theorized to have a role in multi-decadal drought in the Southwest, particularly with respect to summer precipitation (Gray et al. 2003, McCabe et al. 2004). Given these multi-decade "regimes" of ocean circulation, and the severity and persistence of the present multi-year drought, there is a fair likelihood that the current drought will persist for many more years (Stine 1994, Seager et al. 2007), albeit with periods of high year-to-year precipitation variability characteristic of Southwest climate.

The information on how climate change might impact southeastern Arizona is less certain than current drought predictions. However, virtually all climate change scenarios predict that the American southwest will get warmer during the 21^{st} century (IPCC 2001, 2007). Precipitation predictions show a greater range of possibilities, depending on the model and emissions scenario, though precipitation is likely to be less (USGCRP 2001, Seager et al. 2007). To maintain the present water balance with warmer temperatures and all other biotic and abiotic factors constant, precipitation will need to increase to keep pace with the increased evaporation and transpiration caused by warmer temperatures.
Key projections to keep in mind include:

- decreased snowpack — an increasing fraction of winter precipitation could fall as rain instead of snow, periods of snowpack accumulation could be shorter, and snowpacks could be smaller; ironically, due to changes in snow-precipitation characteristics, runoff may decrease even if total precipitation increases (Garfin 2005, Seager et al. 2007);

- earlier snowmelt — increased minimum winter and spring temperatures could melt snowpacks sooner, causing peak water flows to occur much sooner than the historical spring and summer peak flows (Stewart et al. 2004);

- enhanced hydrologic cycle—in a warmer world an enhanced hydrologic cycle is expected; flood extremes could be more common causing more large floods; droughts may be more intense, frequent, and longer-lasting (Seager et al. 2007).

Continuing drought and climate change, when added to the historical and continuing threats, will make native aquatic species conservation in the Gila River Basin even more difficult. The impact of site desiccation to fish is obvious. Frogs may be able to move to another site. Many less obvious effects could occur with drought and a warmer climate. A site with reduced streamflow, or a pond or pool with low water levels could become fishless due to reduced dissolved oxygen. We have seen this occur at three important natural Gila topminnow sites (i.e. Sharp Spring, Redrock Canyon, Cienega Creek). Nonindigenous aquatic species may become more restricted in distribution as well; however, both native and nonindigenous species will be competing for remaining aquatic habitats, and extensive case history suggests that nonindigenous species will win.

Drought and climate change will also impact watersheds and subsequently the water bodies in those watersheds. Drought, and especially long-term climate change will affect how ecosystems and watersheds function. These changes will cause a cascade of ecosystem changes, which may be hard to predict and are likely to occur non-linearly (Seager et al. 2007).

As an example, drought and climate change will cause changes in fire regimes in all southeastern Arizona vegetation communities. The timing, frequency, extent, and destructiveness of wildfires are likely to increase and may facilitate the invasion and increase of nonindigenous plants. These changed fire regimes will change vegetation communities, the hydrological cycle, and nutrient cycling in affected watersheds (Brown et al. 2004). Some regional analyses conservatively predict that acreage burned annually will double with climate change (MacKenzie et al. 2004). Such watershed impacts could cause enhanced scouring and sediment deposition, more extreme flooding (quicker and higher peak flows), and changes to water quality due to increases in ash and sediment within stream channels. Severe watershed impacts such as these, when added to reductions in extant aquatic habitats, will severely restrict sites available for the conservation of native fish and other aquatic vertebrates and make management of extant sites more difficult.

Many of the predictions about the impacts of climate change are based on modeling, but many predictions have already occurred. The tree die-offs and fires that have occurred in the south-west early in this century show the impacts of the current drought. Because of drought, climate change, and human population growth, negative effects to aquatic habitat in the Gila basin continue to occur. The basin's rivers, streams, and springs continue to be degraded, or lost entirely.

CONCLUSION

After reviewing the current status of each species, the environmental baseline for the action area, the effects of the proposed action and the interrelated and interdependent actions, and the cumulative effects, it is the Service's biological opinion that the delivery of CAP water in the Gila River basin, with the implementation of the proposed conservation measures, is neither likely to jeopardize the continued existence of spikedace, loach minnow, Gila topminnow, razorback sucker, Gila chub, or Chiricahua leopard frog nor likely to destroy or adversely modify the critical habitats of spikedace, loach minnow, Gila chub, or razorback sucker. Our rationale for these conclusions is summarized below.

1) The Chiricahua leopard frog occurs at many sites at high elevation that are much less likely to be impacted by nonindigenous species whose movement might be facilitated by the CAP.

2) The proposed barriers will reduce the movement of deleterious nonindigenous species and allow management for the recovery of native species to occur on protected streams.

3) The monitoring program should detect invasions of known or novel nonindigenous species and allow quick action to manage against them.

4) Funding provided for management against nonindigenous species will allow control and research activities to occur that should offset most negative effects from CAP facilitated nonindigenous species.

5) Funding provided for recovery actions for both the fish and the Chiricahua leopard frog will not only mitigate for those effects not addressed by the other conservation actions, but should also improve the status of all six species.

6) The Funding provided for education will create more public support for native aquatic species management and inform the public about issues with nonindigenous species.

7) Though some Gila chub populations are readily accessible to people and are close to CAP related facilities, several other populations are not. Several existing Gila chub populations are or will be protected by existing barriers. Gila chub will also benefit from the two conservation measure funds, through reduction of nonindigenous species and by reestablishment of new populations and other recovery actions.

8) Most spikedace populations are not readily accessible to people or close to CAP related facilities. The populations in the Verde River are above the major dams on both of these rivers. Several existing spikedace populations are, or will be, protected by existing barriers. Spikedace will also benefit from the two conservation measure funds, through reduction of nonindigenous species and by reestablishment of new populations and other recovery actions. There are multiple actions that have been completed and are being planned that will help recover the spikedace (Appendix 4).

9) Razorback sucker populations exist in the Gila basin only as repatriated, non- reproducing, populations. The repatriated populations are in the upper Salt and Verde Rivers, above the major dams on both of these rivers. Therefore, the likelihood of invaders from CAP is a low to moderate risk. The razorback sucker will also benefit from barriers and the two conservation measure funds, through reduction of nonindigenous species, and by reestablishment of new populations and other recovery actions (Appendix 4).

10) Though some Gila topminnow populations are readily accessible to people and close to CAP related facilities, several other populations are not. Several existing Gila topminnow populations are, or will be, protected by existing barriers. Gila topminnow will also benefit from the two funds, through reduction of nonindigenous species and by reestablishment of new populations and other recovery actions. There are multiple actions being planned that will help recover the Gila topminnow (Appendix 4).

11) Most loach minnow populations are not readily accessible to people or close to CAP related facilities. The populations in the upper Salt and Verde Rivers, are above the major dams on both of these rivers. Several existing loach minnow populations are, or will be, protected by existing barriers. Loach minnow will also benefit from the two conservation measure funds, through reduction of nonindigenous species and by reestablishment of new populations and other recovery actions. There are multiple actions that have been completed and are being planned that will help recover the loach minnow (Appendix 4).

12) The PCE for designated critical habitat for Gila chub, spikedace, loach minnow, and razorback sucker that calls for areas free of nonindigenous species will be negatively affected by the proposed action, at least for an interim period. There will also be direct and indirect adverse effects from barrier construction that will be temporary. The various proposed conservation measures will minimize the impacts of nonindigenous species whose movement is facilitated by CAP-associated facilities. However, there will be an interim period of negative effects. The long-term effects to critical habitat for those species should be beneficial, through construction of barriers and management against nonindigenous species.

13) The other PCEs for the four species should only have minor impacts from the proposed action, most of which will be minimized by the proposed conservation measures.

We assume that the proposed action, including all interrelated and interdependent and cumulative effects will be similar to what is described in the biological assessment (USBR 2006) and in this biological opinion.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the Endangered Species Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. "Harass" is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to, or agreement entered into, with the applicants, as appropriate, for the exemption in section 7(o)(2) to apply. In regard to portions of this statement applicable to the applicants, Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to require the applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or extent of take

Take is anticipated and reasonably certain to occur through direct mortality to adult, juvenile, and larval fish and their eggs (except for Gila topminnow which is a livebearer), and adult, juvenile, and metamorph Chiricahua leopard frogs and their eggs due to predation and harassment by nonindigenous aquatic species introduced or spread via CAP; through introduction of nonindigenous parasites and disease organisms; as a result of construction and maintenance of fish barriers; and as a result of O&M of CAP aqueducts and pumping plants. Razorback sucker that are entrained at the pumping station on the Colorado River are already considered “taken,” under the biological opinion for the Lower Colorado Multiple Species Conservation Plan. Razorback suckers that enter the CAP through another avenue may be subject to take through CAP-mediated activities, and are covered under this incidental take statement. We anticipate that any fish or frogs or their eggs or larvae in the construction area of the fish barriers will be killed when crushed by equipment, stranded during flow diversion, exposed to toxic materials such as petroleum products and concrete leachates, or smothered by sediment input.

Take of adult, juvenile, and larval fish and eggs, and adult, juvenile, metamorph, larvae and eggs of frogs may occur in the form of harm from competition for food or habitat by the introduction of nonindigenous aquatic species caused by CAP activities. This take will occur through decreased health, shorter life spans, decreased reproduction, increased loss from predation, and other impairments of breeding, feeding, and sheltering. Take may also occur from habitat or community alteration by CAP-introduced or spread nonindigenous aquatic species, thus disrupting and impairing breeding, feeding, and sheltering.

The anticipated amount of take from nonindigenous species cannot be directly quantified. Take will be highly variable over time and space, ranging from a few listed fish or frogs per year up to, and including, entire populations of each species. Only a portion of the nonindigenous species that may invade can be identified at this time, and the timing of the invasions during the 100-year project duration is unpredictable. In addition, population levels of the listed fish and frogs cannot be accurately described with existing information, and techniques and for the shorter-lived species may vary substantially from year to year and season to season. Individuals consumed by predation cannot be detected, individuals dead from incidental take are difficult to find, and the cause of their death may be difficult to determine. Losses in populations may be masked by fluctuations in numbers that are natural or caused by other factors. However, we anticipate that the amount of take that may occur will be minimized by implementation of the terms and conditions below, as well as the extensive conservation measures proposed by Reclamation.

Regulations at 50 CFR §402.16 require reinitiation of consultation for any of the following reasons: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. Quantifying take is not scientifically defensible or is extraordinarily difficult for the reasons specified above. We therefore propose to base reinitiation of consultation for exceedance of incidental take on whether extirpation of important populations or significant population declines of the listed species occur as a result of CAP-mediated activities. Such changes in populations of the listed species will be determined through monitoring, and we believe that this monitoring and any reinitiation would allow us to assist Reclamation in avoiding jeopardy to these species. We believe this is a scientifically defensible mechanism to avoid violation of ESA Section 7(a)(2).

During fish barrier construction, take may also occur due to destruction or alteration of habitat resulting from modification or destabilization of the substrate, channel, streambanks, and riparian vegetation. Reclamation will make efforts to site barriers in locations where impacts to the native fish population will be minimized. Nevertheless, and such habitat loss would alter behavioral patterns, food availability, access to cover, and availability of habitat, thus reducing survival of individual fish and frogs and potentially reducing or precluding reproduction. The anticipated level of take from barrier construction is also difficult to determine because the specific locations of some of the barriers are currently unknown, and because of the technical difficulties in determining population numbers and mortalities, difficulties in detecting dead or dying individuals, natural population fluctuations, and confounding natural and human-caused factors. The species that may be taken will vary from barrier to barrier. Therefore, anticipated take of these species is indexed to the total aquatic community and habitat for barrier construction. Anticipated take for spikedace, loach minnow, Gila topminnow, razorback sucker, Chiricahua leopard frog, and Gila chub will be considered to have been exceeded if any of the following conditions occur:

1. If at any time during the life of the project, nonindigenous species of concern are determined by FWS and BR, in consultation with the CAP Technical and Policy Committees, to have come from the CAP or through CAP associated pathways, and caused the extirpation of populations at occupied sites listed below. The nonindigenous species of concern are those that are predators of or competitors with the six species, or those that disrupt the functioning of aquatic systems where these species occur.

    1.1. For Gila topminnow, any one level 2 population (as defined by the 1999 draft revised recovery plan); or any three level 3 populations reestablished within any one recovery unit (currently there are four: upper Gila River basin, San Pedro basin, SCR basin, and the lower Gila River basin [Service files]). Definitions of the population levels are found in Appendix 5.

    1.2. For spikedace or loach minnow, any single population which has become established through reestablishment efforts.

    1.3. For Gila chub, any population in the Agua Fria, Gila, or San Pedro river basins (as defined in the final rule listing the species, FR 70 66664).

    1.4. For Chiricahua leopard frog, two populations within any one recovery unit identified in the recovery plan (USFWS 2007).

2. If at any time during the life of the project, nonindigenous species of concern are determined by FWS and BR, in consultation with the CAP Technical and Policy Committees, to have

3. If at any time during barrier activities (including pre-construction, construction, operation, and maintenance), any one or more of the following conditions occur in areas occupied by the listed species addressed in this BO:

    3.1. More than 25 dead native fish or five dead native ranid frogs or larvae are found in the area of barrier construction activities or within 500 yards (460 meters) downstream. The purpose of this term and condition is to detect and control events that may result in take in the aquatic faunal community, such as a spill of toxic materials. Thus, we will consider the death of any native species of fish or native ranid frogs to indicate an exceedance of anticipated take of the listed species.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. Reclamation must immediately provide an explanation of the causes of the taking and review with us the need for possible modification of the reasonable and prudent measures.

Effect of the take

In this biological opinion, we determine that the level of anticipated take is not likely to result in jeopardy to spikedace, loach minnow, Gila topminnow, razorback sucker, Gila chub, or Chiricahua leopard frog, or to adversely modify the critical habitat of any of those species with such designations. However, dependent on the overall status and baseline of the listed species, the loss of the following populations may require reinitiation of this Biological Opinion:

- any natural population of Gila topminnow, spikedace, and loach minnow;

- For Chiricahua leopard frog, any of the following populations: upper Cienega Creek; Blue River above the San Francisco River confluence; right and left prongs of Dix Creek; Coal Creek (Apache-Sitgreaves National Forest); Three Forks (Black River); Crouch, Gentry, or Cherry creeks (Tonto National Forest); and Gila River and tributaries in the Gila Wilderness.

- For Gila Chub: any population in the Verde or Santa Cruz drainage basins; any 2 populations in the Agua Fria, Gila, or San Pedro river basins (as defined in the final rule listing the species, FR 70 66664).

Reasonable and prudent measures and terms and conditions

We believe the following reasonable and prudent measures and terms and conditions are necessary and appropriate to minimize the incidental take authorized by this biological opinion. To be exempt from the prohibitions of section 9 of the Act, Reclamation is responsible for compliance with the following terms and conditions, which implement the reasonable and prudent measures. These terms and conditions are nondiscretionary.

1. We believe the conservation measures of the proposed action include all measures necessary and appropriate to minimize take from that portion of the action related to nonindigenous aquatic species predation, disease, competition, harassment, habitat alteration, disease transmission, and hybridization. Reclamation shall ensure that Gila topminnow and the Santa Cruz basin are considered in the allocation of funds used for minimizing the effects of the proposed action.

    1.1. Implementation of the proposed conservation measures will constitute the terms and conditions implementing reasonable and prudent measure 1.

    1.2. A minimum of eight percent each of the nonindigenous species management and recovery funds will be spent on actions in the SCR subbasin, as measured over a 5-year period, beginning with fiscal year 2008. The CAP Policy Committee can approve variances to this term and condition as needed.

    1.3. A minimum of eight percent each of the nonindigenous species management and recovery funds will be spent on actions on the Gila topminnow, as measured over a 5-year period, beginning with fiscal year 2008. The CAP Policy Committee can approve variances to this term and condition as needed.

2. For the take related to implementation of the conservation measures, we provide the following reasonable and prudent measures and terms and conditions. In areas occupied by listed species addressed in this BO:

    2.1. Conduct all proposed actions in a manner that will minimize direct mortality of spikedace, loach minnow, Gila topminnow, razorback sucker, Chiricahua leopard frog, and Gila chub.

    2.1.1 All reasonable efforts will be made to minimize activities within the waters of the streams in which the fish barriers are constructed. This includes pre-construction investigations, barrier construction, and barrier maintenance, but does not include species monitoring, which is covered by a 10(a)(1)(A) permit.

    2.1.2 All reasonable efforts will be made to minimize activities in the stream channel during the reproductive season of any of the above six species that are in the action area of any particular barrier. This includes pre-construction and barrier maintenance activities, but does not include species monitoring. We recognize that barrier construction is a lengthy process, and it may not be possible to avoid work during reproduction of all listed species present.

2.1.3 All reasonable efforts shall be made to ensure that pollutants do not enter surface waters during any barrier investigation, construction, or maintenance activities. No toxic chemicals (including petroleum products) shall be stored or deposited within the floodplain. An appropriate spill response kit for cleaning up accidental releases of toxic chemicals will be available at the work site whenever work is ongoing, and at least one person present shall have training in use of that kit.

2.1.4 To the extent practical and applicable, recommended conservation measures in Appendix I of the Chiricahua leopard frog recovery plan will be implemented during barrier construction in areas occupied by the frog.

2.2 Conduct all proposed actions in a manner that will minimize loss and alteration of the habitat (including the aquatic faunal community) of spikedace, loach minnow, Gila topminnow, razorback sucker, Chiricahua leopard frog, and Gila chub.

2.2.1 All reasonable efforts will be made to minimize damage to, or loss of, riparian vegetation in streams where fish barriers are constructed. This includes pre-construction investigations, barrier construction, and barrier maintenance.

2.2.2 Whenever barrier pre-construction investigations, construction, or maintenance are conducted in previously unroaded areas or areas closed to vehicular use, all reasonable efforts will be made to obliterate roads, vehicle tracks, or other signs of activity that would encourage non-authorized people to drive in or enter the area. This will be done after each substantially segregated activity, such as between pre-construction activities and construction or between maintenance activities. A road constructed or improved for barrier installation can be kept open for maintenance, if Reclamation, the Service, and the land management entity agree that this is appropriate.

2.2.3 All reasonable efforts will be made to minimize channel and floodplain alterations during barrier pre-construction, construction, and maintenance activities.

2.3 Monitor the fish and frog communities and habitat to document levels of incidental take.

2.3.1 At all times when barrier pre-construction, construction, operation, or maintenance activities are ongoing, reasonable efforts shall be maintained to monitor for the presence of dead or dying fish and ranid frogs in, or within 500 yards (460 meters) downstream of, the project area. The Service shall be notified immediately, by telephone, upon detection of more than 25 dead or dying fish and five (5) ranid frogs of any species. Operations must be stopped between the detection, determination, and resolution of the cause of the mortalities.

2.3.2 A qualified aquatic biologist shall be available to advise and assist in application of these terms and conditions. The biologist does not need to be on-site during all project activities, but must provide training to on-site personnel in how to implement the terms and conditions.

2.4 Maintain complete and accurate records of actions that resulted in take of spikedace, loach minnow, Gila topminnow, razorback sucker, Chiricahua leopard frog, and Gila chub.

2.4.1. A written report shall be submitted to us annually documenting noteworthy CAP activities for the year, any incidental take, and implementation of the conservation measures. The report will include a discussion of compliance with the above terms and conditions.

Disposition of dead or injured listed animals

Upon locating a dead or injured threatened or endangered animal, initial notification must be made to the Service's Division of Law Enforcement, Federal Building, Room 8, 26 North McDonald, Mesa, Arizona (480-835-8289) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph, and any other pertinent information. Care must be taken in handling injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible condition. If feasible, the remains of intact specimens of listed animal species shall be submitted to educational or research institutions holding appropriate State and Federal permits. If such institutions are not available, the information noted above shall be obtained and the carcass left in place.

Arrangements regarding proper disposition of potential museum specimens shall be made with the institution before implementation of the action. Injured animals should be transported to a qualified veterinarian by a qualified biologist. Should any treated listed animal survive, the Service should be contacted regarding the final disposition of the animal.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term conservation recommendations has been defined as Service suggestions regarding discretionary activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information. Recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency’s 7(a)(1) responsibility for these species.

The Service recommends the following conservation recommendations be considered for implementation by Reclamation.

1. Construct additional (to the conservation measures) physical drop structure barriers to upstream fish movement, such as at the following locations:

East Fork White River
Babocomari River, above Huachuca City
Hassayampa River, between the CAP aqueduct and The Nature Conservancy preserve
Agua Fria River, above Lake Pleasant
Mangus Creek
Blue Creek
Tularosa River
Upper San Francisco River
West Fork Gila River
Diamond Creek

2. Unless they are shown at some future date to be needed for the recovery and survival of native fish, and if the actions are not at odds with national wetlands policy, encourage annual dryup of all canals, ditches, siphons, sumps, and other water storage and conveyance features of the CAP and all entities receiving CAP water. This does not include the CAP aqueduct itself, Picacho Reservoir, any reservoirs located on natural stream systems, or any natural rivers or streams. For those and any other open water features which cannot be dried annually, management plans to control nonindigenous aquatic species should be encouraged and assisted. Acceptable alternatives to drying may include modification to avoid flood inundation, or physical barriers to nonindigenous aquatic species movement out of areas which cannot be dried into other portions of the system. The management plans should be mutually acceptable to Reclamation and the Service, in consultation with AGFD and NMDGF (if applicable).

3. Oppose all introductions of any nonindigenous aquatic species not already established in the Colorado River basin, into waters of the basin over which Reclamation has partial or total control. Support efforts to prevent introduction of additional nonindigenous species into the waters of the lower Colorado River basin.

4. Monitor the non-fish nonindigenous aquatic community of the lower Verde and Salt and middle Gila rivers to identify when new species (other than fish, which are already under monitoring) enter the area. Because of the significant effort it would require to monitor for aquatic organisms of all non-fish groups (plants, invertebrates, amphibians, reptiles, mammals) such monitoring could target groups most likely to be introduced via CAP or most likely to result in adverse effects to the six listed species. The groups to be targeted and the protocols for monitoring should be developed in coordination with the Service and AGFD.

REINITIATION NOTICE

This concludes formal consultation on the delivery of CAP water to the Gila River basin and its potential to introduce and spread nonindigenous aquatic species. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

We appreciate the efforts of Reclamation in working with the Service to preserve the native aquatic fauna of the Gila River basin. If we can be of further assistance, please contact Doug Duncan (520) 670-6150 (x236) or Sherry Barrett (520) 670-6150 (x223).

/ s / Sherry Barrett for
Steven L. Spangle

Enclosures

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APPENDIX 1. CONCURRENCES

SONORA TIGER SALAMANDER (*Ambystoma tigrinum stebbensi*)

Status of the Species in the Action Area

The Sonora tiger salamander is known from about 53 breeding localities, although not all are currently occupied (Collins and Jones 1987, Collins 1996, Abbate 1998, USFWS 2002b and files). Populations and habitats are dynamic, thus the number and location of extant aquatic populations change over time, as exhibited by the differences between survey results in 1985 and 1993 to 1996 (Collins and Jones 1987; Collins 1996; James Collins, ASU, pers. comm. 1996). During surveys by the AGFD from 2001 to 2006, Sonora tiger salamanders were found at 37 of 139 stock tanks, which were sampled from 1 to 7 times each. At 23 of 29 tanks where salamanders were found, and which were sampled more than once, salamanders were not found on at least one visit.

All sites where Sonora tiger salamanders have been found are located in Arizona in the Santa Cruz and San Pedro River drainages, including sites in the San Rafael Valley and adjacent portions of the Patagonia and Huachuca mountains in Santa Cruz and Cochise counties. All confirmed historical and extant aquatic populations are found in cattle tanks or impounded cienegas within 19 miles of Lochiel, Arizona. Salamanders collected from a cienega at Rancho Los Fresnos in the San Rafael Valley, Sonora, may be *A. t. stebbinsi* (Varela-Romero et al., 1992). However, surveys during 2006 failed to locate additional salamanders, and most waters on the ranch are now occupied by nonindigenous bullfrogs, crayfish, green sunfish, or black bullhead (trip reports, USFWS files).

For further information on the ecology, taxonomy, range, and threats to this subspecies, refer to U.S. Fish and Wildlife Service (2002b), Collins (1981, 1996), Collins and Jones (1987), Collins et al. (1988, 2003), Gehlbach (1967), Jancovich et al. (1997, 1998, 2005), Jones et al. (1988, 1995), Lowe (1954), Snyder et al. (1996, 1998), Storfer (2003), and Storfer et al. (2004).

Analysis Of Effects

Impacts of nonindigenous fishes and conspecific salamanders to Sonora tiger salamander are potentially the greatest among species considered here. Sonora tiger salamander evolved in systems that may have been devoid of fishes, and populations typically succumb when nonindigenous fishes invade their habitats. However, Sonora tiger salamander now breeds almost exclusively in artificial stock watering tanks in ephemeral drainages that are least accessible to fishes, and thus the threat of nonindigenous species introductions to those habitats is low unless aided by direct bait bucket transfers.

Tiger salamander populations in the western United States and Canada, including populations of the Sonora tiger salamander, exhibit frequent epizootics (Collins et al. 2001). Sonora tiger salamander populations experience frequent disease-related die-offs (about 8% of populations are affected each year) in which almost all salamanders and larvae in the pond die. *A. tigrinum* virus (ATV) is the pathogen believed to be primarily responsible for these die-offs (Jancovich et al. 1997). ATV may be spread by bullfrogs, birds, cattle, or other animals that move among tanks (Jancovich et al. 1997); however, the viral life cycle appears to be restricted to tiger salamanders - no other syntopic hosts have been identified (Jancovich et al. 2001). The disease could be spread by researchers or anglers if equipment such as waders, nets, or fishing tackle used at a salamander tank are not allowed to dry or are not disinfected before use at another tank. ATV may have switched from sport fishes to salamanders or was introduced with water dogs (*A. t. mavortium*) imported for use as fish bait in Arizona and elsewhere (Jancovich et al. 2005). Collins et al. (2003) identified ATV in waterdogs obtained from a Phoenix bait shop.

Sonora tiger salamanders also contract chytridiomycosis, a fungal disease associated with global declines of frogs and toads (Berger et al. 1998, Longcore et al. 1999, Speare and Berger 2000, Davidson et al. 2003). However, compared to anurans, infected salamanders exhibit only minimal symptoms (Davidson et al. 2000).

Conclusion

We concur with Reclamations's determination that the proposed action may affect, but is not likely to adversely affect, the Sonora tiger salamander for the following reasons:

- The San Rafael Valley is more isolated from CAP than other sites in the SCR subbasin, therefore the likelihood that nonindigenous species transported through the CAP will reach these populations is discountable.

- Problematic nonindigenous fish would have to be moved by people to get into the habitats that Sonora tiger salamanders occupy.

DESERT PUPFISH (*Cyprinodon macularius*)

Status of the Species in the Action Area

In Arizona, the family Cyprinodontidae was historically represented by two recognized subspecies, (*Cyprinodon m. macularius*) and (*C. m. eremus*), and an undescribed species, the Monkey Spring pupfish. Echelle et al. (2000) and Minckley et al. (2002) raised *C. m. eremus* to a species, *C. eremus*. Also, Minckley et al. (2002) suggested that the SCR drainage was historically occupied by the extinct Santa Cruz (=Monkey Spring) pupfish, described as *Cyprinodon arcuatus*. This has led to discussion among experts as to whether desert pupfish (*C. macularius*) should be reestablished in the Santa Cruz drainage, since it has been proposed that *C. arcuatus* was the species of pupfish historically found in the Santa Cruz drainage (Minckley et al. 2002). There is general agreement that available suitable habitats in the Santa Cruz drainage should be used for desert pupfish (*C. macularius*) recovery purposes. Both species of pupfish (*C. arcuatus* and *C. macularius*) were extremely similar to each other, and likely ecologically equivalent. Minckley et al. (2002) suggest that the species are similar enough that they were long confounded under *C. macularius*, and the biogeographic considerations suggest that the affinities of *C. arcuatus* lie with *C. macularius* or *C. eremus*. Regardless of the ultimate origins of *C. macularius* and *C. arcuatus*, the Santa Cruz drainage is historical habitat for the genus *Cyprinodon*, and potential recovery habitats in the Santa Cruz should be pursued for *C. macularius*.

There are 13 natural populations that persist; nine of these are in Mexico, and none are in the Gila basin. About 20 transplanted populations exist in the wild (USFWS 1993b). One of the existing populations is semi-captive and is located in a small impoundment at Boyce-Thompson Arboretum, near the town of Superior. Both are small habitats. The Boyce-Thompson site is contaminated with fathead minnow, a nonindigenous fish. The oldest reestablished population is in Cold Spring Seep, a modified spring complex along the northern Gila River escarpment, just west of the town of Safford. Red shiner have been found in Cold Spring Seep, apparently a bait bucket introduction, but appear to have been successfully removed. Desert pupfish have been recently released into two streams in the Agua Fria drainage, three sites in the Aravaipa drainage, Fossil Creek, and streams on the Muleshoe. Only the Agua Fria populations appear to be self-sustaining. The success of the Aravaipa stockings is unclear, as pupfish have not been found post-stocking. Additional stocking of desert pupfish for recovery in the Gila basin is expected over the 100-year project life of CAP.

Analysis Of Effects

No natural populations of desert pupfish are located within the action area. Most areas in which repatriation is likely to occur are isolated, although some may be connected to other surface waters. Although the existing repatriated populations are the sole representatives of this species in the entire Gila basin, the potential for adverse effects from CAP-mediated nonindigenous aquatic species is expected to be very small because there are so few occupied sites. However, some aquatic species dispersing via CAP, such as giant salvinia, might have a substantially increased likelihood of reaching these habitats once introduced into the Gila basin through the CAP aqueduct. The potential impacts from CAP-mediated movement of nonindigenous species to the desert pupfish will be similar to those described for the Gila topminnow, but much smaller in scope and in potential to occur.

Conclusion

We concur with Reclamation's determination that the proposed action may affect, but is not likely to adversely affect, the desert pupfish for the following reasons:

- There are no natural populations, and few reestablished populations in the action area.

- The reestablished populations are isolated, and the likelihood that nonindigenous species transported through the CAP will reach these populations is discountable.

- No barriers are planned at any extant desert pupfish populations.

- The conservation measures should enhance the status of the species.

APACHE TROUT (*Oncorhynchus apache*)

Status of the Species in the Action Area

Historically, Apache trout inhabited most of the streams occurring greater than about one mile in elevation (1,609 meters) in east-central Arizona's White Mountains. By 1950, the only known populations of Apache trout were located on the Fort Apache Indian Reservation (FAIR). Streams occupied today by this trout species within its former historical range are located on the FAIR and the Apache-Sitgreaves National Forest. Apache trout within the action area occur in headwaters of the Salt River system. This includes 12 natural populations and 9 replicate populations. These populations are at the uppermost ends of the action area with a number of intervening dams along the Salt River that separate them from direct influence from CAP mediated nonindigenous aquatic species. Their status in the action area is equivalent to their range-wide status, which is good and improving.

Analysis Of Effects

Apache trout is not expected to sustain significant impacts. Their populations and recovery areas are distant from the CAP aqueduct and above the mainstem dams on the Gila, Salt, and Verde rivers. In addition, there are small fish barriers near the downstream end of most of the Apache trout occupied habitats. The higher, colder waters of the trout habitats are substantially less likely to be successfully colonized by species moving out of the warmwater CAP aqueduct or its related facilities.

Conclusion

We concur with Reclamation's determination that the proposed action may affect, but is not likely to adversely affect, the Apache trout for the following reasons:

- Apache trout habitats are distant from CAP and associated waters, and are above numerous dams and barriers. Therefore, the likelihood that nonindigenous species transported through the CAP will reach these populations is discountable.

- The nonindigenous aquatic species likely to be spread by CAP are likely to be most adapted to warm water, and not the colder water occupied by Apache trout. Therefore, effects of the CAP should be insignificant.

GILA TROUT (*Oncorhynchus gilae*)

Status of the Species in the Action Area

The range of Gila trout is entirely contained within the Gila River basin, so that its status range-wide is equivalent to that in the action area. The Gila trout is endemic to mountain streams in the Gila, San Francisco, Agua Fria, and Verde river drainages in Arizona and New Mexico (Miller 1950, Minckley 1973, Behnke 1992). In 1975, the known distribution of the species consisted of only five relict populations restricted to headwater stream habitats in the upper Gila

River drainage in New Mexico (Main Diamond Creek, South Diamond Creek, McKenna Creek, Spruce Creek, Iron Creek). Before 1900, Gila trout were found in Arizona in the Agua Fria River, Verde River, Eagle Creek, Blue River, and San Francisco River, but the species was extirpated from the state around the turn of the century. The species remained extirpated from Arizona until fish from Main Diamond Creek were translocated into Gap Creek, a tributary of the Verde River, in 1974. This population is believed to be extirpated.

Dude Creek, a tributary of the East Verde River near Payson, was stocked with Gila trout in 1999. In November 2000, Raspberry Creek, a tributary to the Blue River, was stocked with 113 age 0 Gila trout, creating a second Arizona population. Gila trout was also stocked into Strayhorse Creek in the Blue River basin. These fish are considered the representative native trout for the San Francisco and Blue river drainages (David 1998). Within the action area, the status of Gila trout is good and improving, due to extensive recovery efforts that are primarily removal and prevention of invasion of nonindigenous fish.

Analysis Of Effects

Natural and repatriated populations in the tributaries of the upper Gila and San Francisco rivers are near the top of the watershed, but have only one intervening large dam between them and the CAP. All of the others have natural or constructed barriers near their downstream limits. Repatriated populations in Arizona are located in Dude Creek, a tributary of the East Verde River and Raspberry Creek, a tributary of the Blue River. Additional repatriation efforts are expected in headwater streams in the Verde, Blue, and Eagle drainages.

Conclusion

We concur with Reclamation’s determination that the proposed action may affect, but is not likely to adversely affect, the Gila trout for the following reasons:

- Gila trout habitats are distant from CAP and associated waters, and are above numerous dams and barriers. Therefore, the likelihood that nonindigenous species transported through the CAP will reach these populations is discountable.

- The nonindigenous aquatic species likely to be spread by CAP are likely to be most adapted to warm water, and not the colder water occupied by Gila trout. Therefore, effects of the CAP should be insignificant.

APPENDIX 2. Central Arizona Project – section 7 consultations in Arizona.

Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-83-F-10	Central Arizona Water Control Study - Plan 6	F	3/8/83 amended 4/7/83	jeopardy nonjeopardy	bald eagle Yuma clapper rail, Gila topminnow, peregrine falcon
	- Waddell Dam	F	11/15/84 amended 7/2/97	jeopardy	bald eagle
	- Cliff Dam	F	8/15/85	jeopardy	bald eagle
	- Cliff Dam	F	3/10/87	nonjeopardy	Arizona cliffrose
	- Roosevelt Dam (see also 2-21-95-F-462)	F	3/30/90	jeopardy	bald eagle
2-21-83-I-24	New Waddell Pumped Storage Hydroelectric Plant	I		file missing	
2-21-83-I-50	Pump below Granite Reef Dam	I			bald eagle Yuma clapper rail
2-21-83-I-55	CAP upstream water exchange (converted to 2-21-86-F-87)	I	see 2-21-86-F-87		spikedace loach minnow bald eagle
2-22-83-F-74	Upper Gila Water Supply Study (Hooker/Connor Dam)	F	draft 3/9/87	nonjeopardy	Spikedace, loach minnow, bald eagle
2-21-84-F-49	Ft. McDowell Indian Reservation – Rehabilitation and Betterment Irrigation System	F	3/21/85	jeopardy	bald eagle
2-21-84-I-56	Tucson Aqueduct Phase B (CAP)	C F	11/18/85 6/27/86	jeopardy jeopardy	Tumamoc globeberry Thornber's fishhook cactus
2-21-84-I-92	Tonopah Irrigation District CAP water delivery system	I			none

APPENDIX 2 cont'd. Central Arizona Project – section 7 consultations in Arizona.

Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-84-F-96	Papago and San Xavier Indian Reservations (SAWRSA) and Schuk Toak	F	11/2/87	nonjeopardy	Tumamoc globeberry
2-21-84-I-97	Granite Reef aqueduct wildlife water catchments	I		no effect	peregrine falcon
2-21-84-I-98	Avra Valley Irrigation and Drainage District delivery system (CAP)	I			Thornber's fishhook cactus
2-21-85-I-03	Farmers Investment Coop. - CAP water system	I			bald eagle, peregrine falcon Thornber's fishhook cactus
2-2185-I-38	Cave Creek Water Co. storage facility	I			none
2-21-85-I-40	Salt River Indian Community Plan - CAP	I			peregrine falcon Yuma clapper rail
2-21-85-I-41	Papago Chui Chu on-reserva-tion delivery system – CAP	I			Thornber's fishhook cactus
2-21-85-I-66	Castle Hot Springs right-of-way rerouting	I			none
2-21-85-I-106	San Tan Irrigation, Chandler Heights, Queen Creek Districts delivery systems - CAP	I			none
2-21-86-I-22	Ft. McDowell Irrigation Project	I			bald eagle, peregrine falcon Yuma clapper rail

APPENDIX 2 cont'd. Central Arizona Project – Section 7 Consultation History					
Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-86-I-35	Delivery system CAP - Community Water Company of Green Valley, Green Valley Water Company, and New Pueblo Water Company	I			bald eagle peregrine falcon Tumamoc globeberry Thornber's fishhook cactus
2-21-86-I-66	Relocation & reconstruction of US 88 near Government Camp on Lake Roosevelt	I		file missing	
2-21-86-I-73	Gila River Indian Community water and soil conservation study (CAP)	I			Thornber's fishhook cactus Tumamoc globeberry
2-21-86-C-87 2-21-86-F-87	Upper Gila Water Supply Study and Verde River diversions	C F	4/14/86 5/30/90 amended 3/18/94	jeopardy & adverse modification jeopardy & adverse modification of proposed critical habitat	spikedace loach minnow spikedace
2-21-87-I-52	Pan Quemado communication site and road (CAP)	I			Tumamoc globeberry Thornber's fishhook cactus Nichol's turkshead cactus
2-21-87-I-56	High Plains States groundwater recharge demonstration project in	I			Tumamoc globeberry

	Arizona				

APPENDIX 2 cont'd. Central Arizona Project – Section 7 Consultation History

Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-87-I-79	Temporary 69KV line and substation, New Waddell Dam	I			bald eagle peregrine falcon
2-21-87-I-90	Water resources core hole drilling, Tohono O'odham	I			Tumamoc globeberry Nichol's turkshead cactus Thornber's fishhook cactus
2-21-87-I-124	Tucson Aqueduct Reach 6 or Tucson Pipeline/Tunnel	I			Tumamoc globeberry
2-21-88-I-71	New powerplant road and Apache Trail relocation, Roosevelt Dam	I			none
2-21-88-I-72	Proposed wildlife water catchments, New Waddell Dam	I			none
2-21-88-I-113	Los Reales transmission line, CAP	I		no effect	Tumamoc globeberry
2-21-88-I-125	Doe Peak water catchments, New Waddell Dam	I			none
2-21-89-I-34	Wildlife water catchments, Tucson aqueduct	I			Tumamoc globeberry
2-21-89-I-36	Wildlife water catchments, Salt-Gila aqueduct	I			none
2-21-89-I-101	Wildlife water catchments, Pinal County	I			none
2-21-90-I-41	Tucson water treatment plant	I		no effect	Tumamoc globeberry

	spoil site				
2-21-90-I-51	Pasqua Yaqui Reservation	I			Tumamoc globeberry, Gila topminnow, Sanborn's bat

APPENDIX 2 cont'd. Central Arizona Project – Section 7 Consultation History

Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-90-F-119	Pima Lateral Feeder Canal/ Introduction and Spread of nonnative species into Gila River Basin (excluding the Santa Cruz) via CAP	F F (reinitiation)	4/20/94 amended 6/22/95 5/6/98 7/15/98 1/13/00 6/30/00 4/17/01	jeopardy & adverse modification jeopardy nonjeopardy	Spikedace, loach minnow, razorback sucker, Gila topminnow, bald eagle, Colorado squawfish, desert pupfish
2-21-90-I-151	Carefree Water Company upgrade	I			none
2-21-91-I-238	CAP - Salt River Pima-Maricopa Indian Community water use	I		no effect	bald eagle Yuma clapper rail
2-21-91-F-248	Federal Loan Application, Fort McDowell Indian Reservation	F	2/28/92	jeopardy	bald eagle
2-21-91-I-406	Tucson Aqueduct System Reliability (TASRI) - Construction and Filling of reservoir CAP - Nonnative Introduction and Spread in Santa Cruz River subbasin	F I F I	2/11/98 draft 6/11/99 12/6/94 6/5/97	jeopardy is not likely to adversely affect jeopardy no effect is not likely to adversely affect	Pima pineapple cactus Gila topminnow, lesser long-nosed bat, desert pupfish, cactus ferrug. pygmy owl Gila topminnow Spikedace, loach minnow, razorback sucker Colorado squawfish, Sonora tiger salamander, Chiricahua leopard frog
2-21-92-I-41	Salt River siphon, Granite	I		not likely to	bald eagle, Yuma clapper

	Reef Dam			adversely affect	rail, razorback sucker, bonytail chub
2-21-92-I-226	Pima Mine Road pilot recharge project	I			lesser long-nosed bat Tumamoc globeberry
APPENDIX 2 cont'd. Central Arizona Project – Section 7 Consultation History					
Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-92-I-709	Cacti salvage at Lake Pleasant	F	formal withdrawn 12/3/92		bald eagle
2-21-92-I-722	San Carlos Irrigation District Rehabilitation for CAP	I			none
2-21-93-I-86	Gila River Indian Community on-farm development	I			bald eagle, SW willow flycatcher, peregrine falcon, Yuma clapper rail, cactus ferrug. pygmy owl, lesser long-nosed bat
2-21-93-I-124	Sierra Vista wastewater wetlands (converted to 2-21-99-I-097)	I	see 2-21-99-I-097		
2-21-93-I-339	Cortaro-Marana Irrigation District indirect recharge project	I		no effect/ proposed mitigation and time limit, renewed for 1995	Spikedace loach minnow Gila topminnow desert pupfish razorback sucker Colorado squawfish bald eagle
2-21-93-I-412	New River siphon repairs	I			bald eagle peregrine falcon
2-21-95-I-247	Agua Fria siphon repairs	I			peregrine falcon cactus ferrug. pygmy owl
2-21-95-F-	Roosevelt Lake, water level	F	7/17/96	jeopardy	SW willow flycatcher

462	changes		Amended 6/7/99		
2-21-96-I-136	City of Surprise recharge project	I			unknown

APPENDIX 2 cont'd. Central Arizona Project – Section 7 Consultation History

Consultation Number	Project	Formal(F) Informal(I) Conference(C)	Biological Opinion Concurrence Date	Finding	Species
2-21-97-214	Marana High Plains Effluent Recharge Project	I		no effect	SW willow flycatcher cactus ferrug. pygmy owl
2-21-97-F-314	CAP water assignment Camp Verde and Cottonwood	F	3/30/98 Amended 4/28/98	nonjeopardy	razorback sucker SW willow flycatcher Arizona cliffrose
2-21-99-I-097	San Pedro River watershed effluent recharge project	I	1/25/99	is not likely to adversely affect	Huachuca water umbel peregrine falcon SW willow flycatcher
2-21-99-I-190	Construction of San Xavier CAP-Link pipeline	F	5/13/99 Amended 5/26/99	nonjeopardy	Pima pineapple cactus
2-21-99-F-360	Central Avra Valley storage and recharge project	F	12/12/2000	nonjeopardy	cactus ferrug. pygmy owl
2-21-00-I-115	Water exchange agreement between BHP Copper and Tonto Hills Utility Company	I		no effect	AZ hedgehog cactus cactus ferrug. pygmy owl

Appendix 3. Types of actions and their effects considered under section 7 consultation.			
ACTION NAME	ACTION ENTITY	EFFECT TYPES	BIOLOGICAL OPINION SECTION
Past actions	Federal, State, Tribal, or private	direct Indirect	description and effects analysis are in *Environmental Baseline*
Interrelated and interdependent	State, Tribal, or private	direct indirect cumulative	description in *Description of the Proposed Action;* effects analysis in *Effects of the Action* and *Cumulative Effects*
Proposed action	Federal	direct Indirect	description in *Description of the Proposed Action;* effects analysis in *Effects of the Action*
Future non-Federal	State, Tribal, or private	Cumulative	description and effects analysis are in *Cumulative Effects*

Past actions are any actions in the action area that occurred before the date of this consultation. Interrelated actions are those non-Federal actions that are part of a larger action and depend upon that action for their justification. Interdependent actions are those non-Federal actions that have no independent utility apart from the action under consultation. Proposed action is the Federal action under consultation. Future non-Federal actions are any actions in the action area that are reasonably foreseeable to occur. Direct effects are those effects that are a direct result of some action. The term “direct effects” in a section 7 context normally refers to those of the proposed Federal action. However, other related action (past, interrelated, interdependent, future non-Federal) may all have effects that are a direct result of those actions. Indirect effects are those that are caused by some action, but are later in time. The term “indirect effects” in a section 7 context normally refers to those of the proposed Federal action. However, other related actions (past, interrelated, interdependent, future non-Federal) may all have indirect effects. Indirect effects of the proposed Federal action usually refer to those that result from that specific action and do not have an intervening State, Tribal or private action. However, an interdependent and interrelated State, Tribal, or private action may occur as an indirect effect of the Federal action. Cumulative effects result from future non-Federal actions that are reasonably certain to occur.

Appendix 4. Expenditures for the conservation measure funds.

Dollars expended as of May, 2007 by species for each conservation measure fund.									
	Loach minnow	Gila topminnow	spikedace	razorback sucker	Gila chub	Colorado pikeminnow	Desert pupfish	Gila & Apache trouts	Total
Management against nonindigenous species fund									
Dollars	289,729	99,987	148,027	33,990	143,194	7,500	92,240	30,000	844,668
Percent	34	12	18	4	17	1	11	4	
Recovery in lieu of threat removal fund									
Dollars	182,277	65,000	172,277	85,900	36,377	0	0	0	541833
Percent	22	8	20	10	4	0	0	0	
TOTAL									
Dollars	472,006	164,987	320,304	119,890	179,571	7,500	92,240	30,000	1386501
Percent	34	12	23	9	13	1	7	2	

Agreement No. 1425-97-AA-32-00420 (Recovery of Natives, RPA 3) as of May 11, 2007			
Year	**Task**	**Description**	**Notes**
1997	1	Aravaipa Creek geohydrology	Completed
	2	NM spikedace/loach minnow monitoring	Completed
	3	Maintain Gila topminnow stocks	Completed
	4	Bylas Springs geohydrology	Deleted by Mod. 2
	5	Bonita Creek monitoring wells	Deleted by Mod. 2
	6	Klondyke mine tailings	Deleted by Mod. 2
	7	Water rights survey	Pending
	8	Verde River fish study	Deleted by Mod. 6
	9	Augment Gila topminnow populations	Completed
	10	Roundtail chub status survey	Completed
	11	Aravaipa Creek fish monitoring	Deleted by Mod. 5
	12	Achii-Hanyo growout enhancement	Completed
	13	Middle Gila River spikedace survey	Deleted by Mod. 7
1999	14	Spikedace/loach minnow stockings	Deleted by Mod. 7
	15	Status of Rio Rico topminnow	Deleted by Mod. 5
	16	Razorback/squawfish assessment	Completed
	17	Verde River loach minnow survey	Completed
	18	Database integration	Deleted by Mod. 5
	19	Spikedace/loach minnow declines	Moved to task 76
	20	Razorback sucker skeletal deformities	Deleted by Mod. 5
	21	Larval fish key (yr 1 of 2)	Completed
	22	Achii-Hanyo growout enhancement	Deleted by Mod. 6
	23	San Juan growout ponds	Deleted by Mod. 6
	24	Spikedace propagation (yr 1 of 2)	Completed
	25	FWS coordination	Completed
2000	26	Artificial stream design/construction	Deleted by Mod. 7
	27	Fish database workshop and manual	Completed
	28	Redrock Canyon stock tank renovations	Deleted by Mod. 7
	29	Larval fish key (yr 2 of 2)	Completed
	30	Spikedace propagation (yr 2 of 2)	Completed
	31	Redrock Ranch acquisition	Deleted by Mod. 10
2001	32	Blue River hatchery easement	Deleted by Mod. 10
	33	Artificial stream construction	Deleted by Mod. 7
	34	Maintain Gila topminnow stocks	Completed
	35	Technical monitor	Completed
2002	36	Loach minnow progagation	Completed
	37	Gila topminnow stockings	Moved to task 75
	38	AZ trout stream repatriations	Moved to task 75
	39	NM trout stream repatriations	Moved to task 76
	40	Redrock Canyon repatriations	Moved to task 75

	41	Arnett Creek repatriations	Moved to task 75
	42	Blue River repatriations	Moved to task 75
	43	Miscellaneous support expenses	Ongoing
	44	Maintain Gila topminnow stocks	Completed
	45	Hatchery facilities needs	Deleted by Mod. 11
	46	Gila basin chub genetics	Completed
2003	47	Hot Springs Canyon repatriations	Moved to task 75
	48	Acquire rare populations (yr 1 of 2)	Moved to task 75
	49	Identify native-only streams (yr 1 of 2)	Pending
	50	Chub propagation techniques (yr 1 of 3)	Completed
	51	Aravaipa topminnow helicopter support	Completed
	52	GIS database development	Deleted by Mod. 10
	53	Acquisition of renovation chemicals	Completed
	54	Romero and Paige Creek renovations	Ongoing
2004	55	Salt River repatriations	Deleted by Mod. 11
	56	Maintain Gila topminnow stocks	Completed
	57	Acquire rare populations (yr 2 of 2)	Moved to task 75
	58	Identify native-only streams (yr 2 of 2)	Pending
	59	Chub propagation techniques (yr 2 of 3)	Completed
	60	Turkey Creek repatriations	Completed
	61	Post/Welch repatriations	Moved to task 75
	62	Ash Creek repatriations	Moved to task 75
	63	Acquisition of fish transport gear	Completed
	64	San Pedro Pond stockings	Moved to task 75
	65	Pupfish genetics (yr 1 of 3)	Completed
	66	Post repatriation evaluations	Pending
2005	67	Chub propagation techniques (yr 3 of 3)	Ongoing
	68	Pupfish genetics (yr 2 of 3)	Completed
	69	Bubbling Ponds Hatchery development	Completed
2006	70	Pupfish genetics (yr 3 of 3)	Ongoing
	71	San Pedro pond reconstruction	Completed
	72	Bubbling Ponds O&M (yr 1 of 5)	Ongoing
	73	Miscellaneous helicopter support	Ongoing
	74	Topminnow stock maintenance	Ongoing
	75	AZGFD recovery actions (yr 1 of n)	Ongoing
		Gila topminnow stockings (37)	
		AZ trout stream repatriations (38)	
		Redrock Canyon repatriations (40)	
		Arnett Creek repatriations (41)	
		Blue River repatriations (42)	
		Redfield/Hot Springs repatriations (47)	
		Acquire rare populations (48, 57)	

		Post/Welch repatriations (61)	
		Ash Creek repatriations (62)	
		San Pedro Pond stockings (64)	
		Meda/Tiaroga data assembly-AZ	
		Fossil Creek repatriations	
	76	NMDGFD recovery actions (yr 1 of n)	Ongoing
		Spikedace/loach minnow declines (19)	
		NM trout stream repatriations (39)	
		Meda/Tiaroga data assembly-NM	
		Gila forks inventory (yr 1 of 2)	
	77	USFS Gila forks inventory (yr 1 of 2)	Ongoing
2007	78	AZGFD recovery actions (yr 2 of n)	Pending
		Repatriate chub to Mineral Creek	
	79	NMDGFD recovery actions (yr 2 of n)	Pending
		Gila forks inventory (yr 2 of 2)	
		Spikedace repatriation (yr 1 of 5)	
		Gila forks community isotopes (yr 1 of 3)	
		Red Rock cienega restoration (yr 1 of 2)	
	80	USFS Gila forks inventory (yr 2 of 2)	Pending
	81	Bubbling Ponds O&M (yr 2 of 5)	Pending
	82	Additional cost for yr 2 of task 74	Pending
	83	Additional cost for task 67	Pending

Agreement No. 1425-97-AA-32-00410 (Control of Nonnatives, RPA 4) as of May 11, 2007			
Year	Task	Description	Notes
1997	1	Removal of mosquitofish	Deleted by Mod. 2
	2	Down Under Tank	Deleted by Mod. 13
	3	Diseases and pathogens	Completed
	4	Kingfisher ponds	Deleted by Mod. 7
	5	E Fk White River barrier feasibility	Completed
	6	NM fish stocking records	Deleted by Mod. 14
	7	Piscicide development	Completed
	8	Cottonwood Spring barrier	Completed
	9	FWS coordination	Completed
	10	Contingency management fund	Deleted by Mod. 2
	11	Ichthyocide acquisition	Completed
1999	12	Flathead suppression	Deleted by Mod. 7
	13	Stock tank easements	Pending
	14	Ichthyocide acquisition	Completed
	15	Blue River barrier design	Ongoing
	16	White River barrier design	Deleted by Mod. 7
	17	O'Donnell Cienega renovation	Deleted by Mod. 7

	18	Verde River barrier feasibility	Deleted by Mod. 11
2000	19	Crayfish control technology	Completed
	20	Fossil Creek renovation	Completed
	21	Fossil Creek barrier feasibility	Completed
	22	Granite Creek barrier feasibility	Completed
	23	Boyce-Thompson renovation	Moved to task 64
	24	Ichthyocide acquisition	Completed
	25	Verde River barrier design	Deleted by Mod. 8
	26	Piscicide susceptibility	Deleted by Mod. 7
	27	FWS coordination	Completed
2001	28	Transgenic fish feasibility	Completed
	29	Blue River hatchery water rights	Deleted by Mod. 11
	30	Fossil Creek stock tank survey	Completed
	31	Fossil Creek barrier design	Completed
2002	32	Redfield/Hot Springs barrier feasibility	Ongoing
	33	Redfield/Hot Springs barrier design	Ongoing
	34	Bonita Creek barrier feasibility	Completed
	35	NM barriers feasibiltiy	Completed
	36	FWS coordination	Completed
	37	Redrock Canyon barrier design	Ongoing
	38	Crayfish removal from Fossil Creek	Completed
	39	Production of SW fishes book	Ongoing
	40	Independent technical monitor	Completed
2003	41	Tonto Creek barrier feasibility	Ongoing
	42	Acquisition of renovation supplies	Completed
	43	Acquisition of renovation chemicals	Completed
	44	Cottonwood Spring barrier construction	Deleted by Mod. 11
	45	Technical monitor	Completed
2004	46	O'Donnell Canyon barrier feasibility	Completed
	47	Fossil Creek stock tank renovations	Completed
	48	AZ oversight of renovations	Ongoing
	49	Lewis Springs barrier feasibility	Completed
	50	Stillman Lake renovation NEPA	Ongoing
	51	Miscellaneous stock tank surveys	Pending
	52	Barrier and renovation effectiveness	Completed
	53	Fund Transfer Program effectiveness	Completed
2005	54	Travel costs for transgenic fish briefing	Completed
	55	Helicopter support for Fossil Creek	Completed
	56	Additional funding for prior tasks	Completed
	57	Antimycin purchase for Fossil Creek	Completed
	58	Rotenone purchase for Fossil Creek	Completed

2006	59	USFS Gila mechanical removal (1 of 4)	Ongoing
	60	FWS Gila mechanical removal (1 of 4)	Ongoing
	61	Stillman Lake renovation	Ongoing
	62	Additional BPH construction funds	Completed
	63	Little Creek barrier design	Ongoing
	64	AZGFD nonnative control actions (yr 1 of n)	Ongoing
		Boyce-Thompson renovation (23)	
		Fresno Canyon renovation	
	65	NMDGFD nonnative control actions (yr 1 of n)	Ongoing
		NM mechanical removal (yr 1 of 4)	
	66	Emergency salvage facility needs	Completed
2007	67	West Fork Oak Creek fish barrier design	Pending
	68	USFS Gila mechanical removal (yr 2 of 4)	Pending
	69	FWS Gila mechanical removal (yr 2 of 4)	Pending
	70	AZGFD nonnative control actions (yr 2 of n)	Pending
		Redrock Canyon renovation	
		Bonita Creek renovation	
	71	NMDGFD nonnative control actions (yr 2 of n)	Pending
		Gila mechanical removal (yr 2 of 4)	
	72	Genetic biocontrol symposium	
	73	Rotenone purchase (new formulation)	Pending
	74	Additional O&M costs for Bubbling Ponds Hatchery	Pending

APPENDIX 5.
Gila topminnow recovery plan (Weedman 1999) population levels

The three-level approach recommended for reestablishing Gila topminnow populations is similar to that used in the Desert Pupfish Recovery Plan (U.S. Fish and Wildlife Service 1993b). Natural populations in the Gila River Basin represent the only genomes available for recovery of this species in the U.S. These populations are designated as *Level 1* and should receive the highest priority for protection. Populations reestablished in wild sites with natural habitats capable of sustaining a viable population with minor human intervention and persisting a minimum of 10 years will be considered *Level 2* populations. These Level 2 populations may inhabit naturally occurring sites that have been artificially enhanced, but don't require routine maintenance for their survival. Captive populations will not be considered as Level 2 populations. Populations reestablished in the wild or captive natural, semi-natural, or artificial habitats that do not sustain a viable population for at least 10 years without human intervention will be classified as *Level 3* populations. Level 3 populations may require extensive human intervention and may be lost during recovery actions if additional populations are reestablished, either in the same locale or elsewhere.