United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. Box 1306
Albuquerque, New Mexico 87103

In Reply Refer To:
R2/ES-SE
2-21-90-F-119

APR 29 1994

MEMORANDUM

To: Regional Director, Bureau of Reclamation, Boulder City, Nevada

From: Regional Director, Region 2

Subject: Final Biological Opinion on the Transportation and Delivery of Central Arizona Project Water to the Gila River Basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers, and associated tributaries) in Arizona and New Mexico

Attached is the Fish and Wildlife Service's final biological opinion on the subject formal consultation under section 7 of the Endangered Species Act of 1973, as amended. This opinion finds that the action would jeopardize the continued existence of the spikedace (Meda fulgida), loach minnow (Tiaroga cobitis), Gila topminnow (Poeciliopsis occidentalis), and razorback sucker (Xyrauchen texanus) and would adversely modify the critical habitat of the spikedace, loach minnow, and razorback sucker. The reasonable and prudent alternative given in this opinion is the product of over 3 years' of negotiation between the Fish and Wildlife Service and the Bureau of Reclamation (BR). We appreciate the efforts of BR to finding a way to conserve the listed species and look forward to working with you on implementation of this opinion. If we can be of further assistance, please contact Sally Stefferud or Tom Gatz in the Arizona Ecological Service State Office, at (602) 379-4720.

Attachment

cc:
Project Manager, Bureau of Reclamation, Phoenix, AZ
Director, U.S. Fish and Wildlife Service, Washington, D.C. (DES)
State Supervisors, Ecological Services State Offices, Arizona and New Mexico
Project Leader, U.S. Fish and Wildlife Service, Pinetop, AZ
Assistant Regional Director - Endangered Species, Region 2

2-21-90-F-119

SUMMARY
BIOLOGICAL OPINION ON TRANSPORTATION AND DELIVERY OF CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN IN ARIZONA AND NEW MEXICO

Date of the opinion: April 15, 1994

Action agency: Bureau of Reclamation

Project: Transportation and delivery of Colorado River water through the Central Arizona Project (CAP) to various water users in the Gila River basin (excluding the Santa Cruz River subbasin). This biological opinion addresses only the potential of this project to introduce and spread non-native aquatic species. The Santa Cruz subbasin will be the subject of additional formal consultation.

Listed species and critical habitats: Spikedace (Meda fulgida), loach minnow (Tiaroga cobitis), Gila topminnow (Poeciliopsis occidentalis occidentalis), razorback sucker (Xyrauchen texanus), desert pupfish (Cyprinodon macularius), Colorado River squawfish (Ptychocheilus lucius), and bald eagle (Haliaeetus leucocephalus). Critical habitats for spikedace, loach minnow, and razorback sucker.

Biological opinion: Jeopardy for spikedace, loach minnow, Gila topminnow, and razorback sucker. Adverse modification of critical habitat for spikedace, loach minnow, and razorback sucker. (page 1)

Reasonable and prudent alternative (RPA): Implementation of the RPA is *necessary to remove the threat of jeopardy* from the proposed action. Construction of 4 drop-structure barriers (2 on Aravaipa Creek, 2 on San Pedro River), continued operation of 3 existing electrical barriers on canals, monitoring of non-native fish in specific areas of middle Gila basin and canals, transfer of $500,000 annually to FWS for conservation of Gila basin native fishes and research and non-native fish control, development and implementation of an information and education program about the adverse effects of non-native fish. (pages 26 to 29)

Incidental take statement:

Level of take anticipated: Anticipated take is unquantifiable, but will be assumed to have been exceeded if proposed action, as modified by RPA, is altered or not carried out. If the anticipated incidental take is exceeded, consultation must be reinitiated. (pages 29-30)

Reasonable and prudent measures and terms and conditions: Implementation of the RPA. Terms and conditions are *mandatory requirements*. (page 30)

Conservation recommendations: Implementation of conservation recommendations is *discretionary*. Construction of 4 drop-structure barriers, encouraging dry-up of CAP connected irrigation canals and other features and management of non-native fishes in those not appropriate for dry-up, organization and facilitation of multi-agency efforts to address conflicts between sport fishing and native fish conservation, and opposition to introduction of additional non-native aquatic species in the lower Colorado River basin. (page 31)

Additional section 7 consultation needs: Further consultation will be required for effects the Santa Cruz River basin (excluding the Santa Rosa Canal system.

2-21-90-F-119

U.S. FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES ACT SECTION 7 BIOLOGICAL OPINION

TRANSPORTATION AND DELIVERY OF CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN (HASSAYAMPA, AGUA FRIA, SALT, VERDE, SAN PEDRO, MIDDLE AND UPPER GILA RIVERS AND ASSOCIATED TRIBUTARIES) IN ARIZONA AND NEW MEXICO

April 15, 1994

This biological opinion has been prepared in response to the February 12, 1991, request by the Bureau of Reclamation (BR) for formal consultation with the Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended, on the proposal to provide Central Arizona Project (CAP) water to Indian and non-Indian water users in central Arizona. For the purposes of this consultation, the Gila River basin does not include the Santa Cruz River or its tributaries but does include the Santa Rosa Canal system. Formal section 7 consultation on the Santa Cruz River basin will be conducted separately from the rest of the Gila River basin consultation.

The species of concern in this opinion are the threatened spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis); and the endangered Gila topminnow (Poeciliopsis occidentalis occidentalis), desert pupfish (Cyprinodon macularius), Colorado River squawfish (Ptychocheilus lucius), razorback sucker (Xyrauchen texanus), and bald eagle (Haliaeetus leucocephalus). The consultation began on February 12, 1991, the date the BR request was received by the FWS. A draft biological opinion was delivered to BR on May 30, 1991, for review of the technological and economical feasibility of the reasonable and prudent alternative. The consultation was extended six times to allow for development of a complex reasonable and prudent alternative. On March 2, 1994, BR notified the FWS of their acceptance of the reasonable and prudent alternative and requested a final opinion.

The following biological opinion is based on information contained in the biological assessment prepared by the BR, project data from BR, data in our files, and other sources of information.

BIOLOGICAL OPINION

It is the FWS's biological opinion that the proposed delivery of CAP water to water users in central Arizona is likely to jeopardize the continued existence of the threatened spikedace and loach minnow and the endangered Gila topminnow and razorback sucker and is likely to adversely modify the critical habitat of the spikedace, loach minnow, and razorback sucker. It is the FWS's biological opinion that the proposed delivery of CAP water to water users in central Arizona is not likely to jeopardize the continued existence of the endangered desert pupfish, Colorado River squawfish, or bald eagle. This opinion concerns only the transport and delivery of water, not the construction of new facilities to convey the water or the development of new agricultural lands.

BACKGROUND INFORMATION

Species Descriptions

Spikedace

The spikedace was listed as a threatened species on July 1, 1986. Critical habitat was designated for the spikedace on March 8, 1994, and includes portions of the Verde and Gila Rivers and Aravaipa Creek. The spikedace is a small silvery fish, with the common name alluding to the well-developed spine on the dorsal fin (Minckley 1973). Spikedace originally existed throughout much of the Gila River drainage above Phoenix, but is currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the Verde River (Yavapai County, Arizona), and Eagle Creek (Greenlee County, Arizona). A recent record of the spikedace also exists from the middle Gila River upstream from Ashurst-Hayden Dam (USDI BR 1992). Habitat destruction and competition and predation from introduced non-native fish species are the primary causes of the species' decline (Propst et al. 1986, Rinne 1991).

Loach Minnow

The loach minnow was listed as threatened on October 28, 1986. Critical habitat was designated for the loach minnow on March 8, 1994, and includes portions of the Gila, San Francisco, Blue and Tularosa Rivers and Aravaipa, Campbell Blue, and Dry Blue Creeks. A small, elongated fish, the loach minnow is olive-colored with small white or orange spots at the base of the dorsal and caudal fins (Minckley 1973). Loach minnow were once common in the Gila River above Phoenix but are now found in only six locations: Aravaipa Creek (Graham and Pinal Counties, Arizona), upper Gila, San Francisco and Tularosa Rivers (Catron and Grant Counties, New Mexico), the White River (Navajo and Gila Counties, Arizona) and the Blue River (Greenlee County, Arizona). Habitat destruction and competition and predation from introduced non-native fish species are the primary causes of the species' decline (Propst et al. 1988, Propst and Bestgen 1991).

Gila Topminnow

The Gila topminnow was listed as endangered on March 11, 1967. No critical habitat has been designated for this species. The Gila topminnow is a small, livebearing fish found in the Gila, Sonora, and de la Concepcion River drainages in Arizona, New Mexico, and Sonora, Mexico (Minckley 1973, Vrijenhoek et al. 1985). It was once among the most common species of the Gila River and its tributaries (Hubbs and Miller 1941). Destruction and alteration of its habitat plus competition with and predation by non-native fish species have resulted in extirpation of the Gila topminnow throughout most of its range (USDI FWS 1984, Meffe et al. 1983). Nine naturally occurring populations of Gila topminnow remain, all but one located in the Santa Cruz River basin. One naturally occurring population is found in three small adjacent spring systems just off the Gila River on the San Carlos Indian Reservation near Bylas, Graham County, Arizona. Stocked populations of Gila topminnow are found throughout the Gila River basin in Arizona, primarily in isolated springs and spatially intermittent streams.

Desert Pupfish

The desert pupfish was listed as endangered on March 31, 1986. Critical habitat for this species was designated at Quitobaquito Spring, Organ Pipe Cactus National Monument, Pima County, Arizona, and at three locations in Imperial County, California. The desert pupfish is a small fish historically

common throughout much of the lower Gila, lower Colorado, and Sonoyta River systems in Arizona, California, and Sonora, Mexico (Minckley 1973). Decline of the desert pupfish is due to destruction and alteration of its habitat and introduction of predatory and competitive non-native fishes. Natural populations of desert pupfish now exist in three Imperial County, California locations; Quitobaquito Spring, Pima County, Arizona; Rio Sonoyta, Sonora, Mexico, and scattered sites in the lower Colorado River delta in Baja California and Sonora, Mexico (Black 1980, Miller and Fuiman 1987, Schoenherr 1988, Hendrickson and Varela-Romero 1989). Stocked populations of the desert pupfish are found in isolated springs and spatially intermittent streams scattered throughout the Gila River basin in Arizona and the Salton basin in California.

Razorback Sucker

The razorback sucker was listed as endangered on October 23, 1991. Critical habitat was designated for this species on March 21, 1994. Within the Gila River basin, the critical habitat includes portions of the Verde, Gila, and Salt Rivers. The razorback sucker grows to over two feet in length and has a distinctive abrupt, sharp-edged, dorsal ridge behind the head (Minckley 1973). It was once common throughout the Colorado River basin, but now exists sporadically in only about 750 miles of the upper basin. In the lower basin a substantial population exists only in Lake Mohave, but they do occur upstream in Lake Mead and the Grand Canyon and downstream sporadically on the mainstem and associated impoundments and canals (USDI FWS 1991a). Habitat alteration and destruction, along with competition and predation from introduced non-native fish species, are responsible for the species' decline (Marsh and Brooks 1989, Bestgen 1990). Razorback suckers have been stocked into numerous locations in the Gila, Salt, and Verde River basins in a attempt to recover the species.

Colorado Squawfish

The Colorado squawfish was listed as endangered on March 11, 1967. No critical habitat has been designated for this species. On July 24, 1985, the Salt River from Roosevelt Dam upstream to U.S. Highway 60 bridge, and the Verde River from Horseshoe Dam upstream to Perkinsville were designated as locations for experimental, non-essential populations of Colorado squawfish. Those areas were subsequently stocked with that species. The Colorado squawfish is a large, silvery minnow which grows up to six feet long (Minckley 1973). It was once common throughout the Colorado River system, including the Gila River basin, but natural populations are now found only in scattered areas of the upper Colorado River system in Utah, Colorado, and New Mexico (USDI FWS 1991b). The decline of the species is due to habitat alteration and destruction and to introduction of predacious and competitive non-native fish (USDI FWS 1991b).

Bald Eagle

The bald eagle was listed as endangered on March 11, 1967, and no critical habitat has been designated for this species. The desert-nesting population of this large, fish-eating eagle breeds earlier than its more northern-dwelling counterparts. Loss of riparian forests, some of the impacts created by reservoirs, and drying of rivers contributed to the decline of this species. Bioaccumulation of pesticides and other toxic substances adversely affected reproduction. Currently, bald eagles nest along the Bill Williams, Agua Fria, Verde, Salt, and Gila Rivers and their tributaries in central Arizona.

Project Description

The CAP was constructed to provide a long term, non-groundwater, water source for municipal, industrial, and non-Indian and Indian agricultural users in Arizona. The water provided through the CAP aqueduct system represents Arizona's allocation of the flow of the Colorado River. The water is taken from the Colorado River at Lake Havasu and is conveyed across the state in a series of large open aqueducts (Figure 1). A storage option for CAP water became available December 1992 following enlargement of Lake Pleasant, an existing reservoir on the Agua Fria River north of Phoenix. Water is pumped into the reservoir when the aqueduct is carrying more than the demand requires and pumped out to make up demands during other times of the year.

The CAP system was declared completed in October of 1993 and its expected project life is 100 years. Water deliveries are currently ongoing to supply agricultural, municipal, and industrial users listed in Tables 1 and 2. Figure 2 shows the general location of the entities receiving water through the CAP.

The issue under discussion in this opinion is the transfer of non-native fish species from the Colorado River and other sources of introduction along the aqueduct system into the waters of the Gila River basin in Arizona and portions of western New Mexico. The CAP aqueduct has been in operation long enough that field collection data support initial hypotheses that fish populations are able to exist in the aqueducts. At present, fish largely originate from Lake Havasu, although reproduction of some species has been documented in the aqueduct and another source of fish became available with storage of CAP water in Lake Pleasant (Grabowski et al. 1984, USDI BR 1987, USDI BR 1988, Matter 1991).

We have identified several tributaries to the Gila River that, because of the proximity to either the CAP aqueduct or users of CAP water, may have the potential for non-native fish species to be introduced to them via the CAP.

Hassayampa River

The Hassayampa River is crossed by the CAP aqueduct approximately 24 miles upstream of its confluence with the Gila River. Several irrigation districts are in the vicinity of the river; the Harquahala Valley and Tonopah, both of which drain to Centennial Wash, and the Buckeye and Roosevelt which are adjacent to the Gila River at and above its confluence with the Hassayampa. The Gila River at the Hassayampa confluence often has water year round due to treated effluent outflows from the Phoenix metropolitan area and irrigation returns from the agricultural fields. The Hassayampa is usually dry throughout the reach of interest, although permanent water is found upstream near Wickenberg.

Agua Fria River

The CAP aqueduct crosses the Aqua Fria downstream of Lake Pleasant's New Waddell Dam. Beginning in December 1992 CAP water has been stored in the Lake Pleasant. Although the Agua Fria is seasonally dry above Lake Pleasant, water flows into the lake occurs over a several month period in winter and spring and monsoon generated flash floods are common summer occurrences. Water is occasionally spilled downstream from Lake Pleasant, such as during the flooding in January-February 1993.

TABLE 1. CENTRAL ARIZONA PROJECT WATER DELIVERIES FOR AGRICULTURAL USES IN 1993.

AG USERS
MONTHLY DELIVERIES
CALENDER YEAR 1993
Table #1

SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CAIDD/CMA →# :	0	435	4,669	8,614	9,094	12,026	14,479	10,590	2,229	386	75	426	63,024
CAIDD/SRD →# :	0	133	2,529	3,200	2,147	3,878	4,721	3,984	204	55	0	321	21,172
CAIDD/SHA →# :	0	143	1,468	1,863	1,504	3,015	2,651	2,136	775	129	15	19	13,698
Chandler Hts → :	0	0	239	89	223	198	204	188	148	0	0	0	1,289
Hohd/CG Ext. → :	0	1,174	4,321	3,005	4,593	7,371	8,927	7,291	445	657	261	1,661	39,706
Hohd/Kleck → :	25	199	519	454	596	486	334	172	22	0	18	200	3,025
MSIDD →# :	0	1,228	22,224	14,204	13,383	20,115	26,255	17,145	1,765	52	104	4,049	120,525
New Magma →# :	0	480	2,808	6,613	7,853	8,823	14,324	13,580	4,538	413	199	0	59,434
Queen Creek →#:	22	346	2,887	4,039	3,956	5,155	6,383	6,162	2,263	154	14	19	31,400
San Tan → :	0	0	266	601	693	807	1,362	744	803	0	0	0	5,276
Tohono → :	0	0	306	1,075	1,489	2,216	2,868	2,311	772	0	0	0	11,037
Sub Total	47	4,139	42,236	43,757	45,331	64,090	82,488	64,304	13,962	1,851	686	6,695	369,586

NON-SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
B.K.W. Farms → :	0	0	0	0	0	0	0	250	0	0	0	0	250
Cort-Harana → :	0	0	0	0	0	294	1,548	791	17	0	0	0	2,650
Great W. Jojoba:	0	0	0	0	0	0	0	0	0	0	0	0	0
Harq. Valley @ :	18	222	1,211	4,203	3,676	4,452	5,427	4,576	1,990	615	85	854	27,329
James M. Jones :	0	0	0	36	39	0	0	0	0	0	0	0	75
MWD :	0	0	0	0	0	0	0	0	0	0	0	0	0
Roosevelt → :	0	0	0	0	0	7,259	8,107	6,462	4,541	0	0	0	26,369
San Carlos IDD :	0	0	0	0	0	0	0	0	0	0	0	0	0
Semilla Farms :	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total	18	222	1,211	4,239	3,715	12,005	15,082	12,079	6,548	615	85	854	56,673

INDIANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Ak-Chin Farms :	44	1,876	6,697	9,969	9,908	10,902	13,081	11,152	5,430	4,283	755	2,604	76,701
Gila River Ind.:	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total	44	1,876	6,697	9,969	9,908	10,902	13,081	11,152	5,430	4,283	755	2,604	76,701
TOTAL (AG)	109	6,237	50,144	57,965	58,954	86,997	110,651	87,535	25,940	6,749	1,526	10,153	502,960

TABLE 2. CENTRAL ARIZONA PROJECT WATER DELIVERIES FOR MUNICIPAL AND INDUSTRIAL USES IN 1993.

M&I USERS
MONTHLY DELIVERIES
CALENDER YEAR 1993
Table #2

SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Az. Water Co. :	0	0	0	0	0	117	137	135	131	135	127	43	825
Carefree :	0	0	0	11	30	36	41	32	34	18	0	0	202
Cave Creek :	14	10	10	20	19	25	24	38	19	22	15	15	232
Chandler * :	117	239	177	12	88	93	63	43	44	135	155	0	1,166
Chaparral :	83	99	0	0	69	158	159	164	160	153	154	207	1,416
Eloy :	0	6	19	25	25	69	52	44	31	31	10	28	340
Gilbert :	0	0	0	0	0	0	0	0	0	0	4	5	9
Glendale :	836	279	25	558	548	928	1,088	1,012	991	1,441	569	641	8,916
Maricopa County:	8	13	25	47	52	77	72	64	58	35	23	19	493
Mesa :	675	570	1,558	1,030	1,558	2,074	2,697	2,360	2,136	1,912	1,841	778	19,247
Phoenix * :	7,722	134	782	1,326	4,755	7,375	8,384	8,297	4,835	8,199	5,072	5,488	60,969
Queen Creek :	0	0	0	0	0	0	0	0	0	0	6	19	25
Rio Verde * :	0	0	0	250	0	0	0	0	0	0	0	0	250
Scottsdale * :	1,200	1,170	1,496	1,705	1,692	2,179	2,391	2,396	2,222	2,402	1,891	1,719	22,663
Tempe * :	0	0	0	933	0	0	0	0	0	714	780	0	2,427
Tucson :	2,786	2,795	4,016	4,755	5,025	5,149	5,228	4,421	4,944	3,423	1,849	1,924	46,315
Sub Total	13,441	5,315	8,118	10,680	14,101	18,280	20,936	17,008	15,605	18,630	12,497	10,886	165,495

NON-SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Ancala :	3	6	18	29	53	48	49	33	37	44	16	18	353
C.S. McCrossan :	0	5	6	1	4	5	0	0	0	0	0	0	21
Dragosz :	0	0	0	0	0	7	4	7	7	0	0	7	32
J.W.J. Contr Co:	0	1	7	12	24	26	1	1	14	15	9	2	112
Mazatzal Farm :	0	1	1	2	3	3	4	4	4	3	1	2	28
PCL Civil Const:	0	0	0	0	0	11	11	1	11	4	3	5	46
Picacho School :	0	0	0	1	3	6	3	4	0	0	0	0	17
Red Mt. Ranch :	2	8	25	42	52	66	68	51	51	75	22	19	491
Sonoran Lnd Grp:	0	0	0	0	0	0	0	0	0	0	0	0	0
Viewpoint :	2	2	5	12	19	18	18	12	14	18	5	6	131
Sub Total	7	23	62	98	168	190	156	113	138	159	56	59	1,231
TOTAL (M&I)	13,448	5,338	8,180	10,778	14,269	18,470	21,094	17,119	15,743	18,789	12,553	10,945	166,726
GRAND TOTAL	13,557	11,575	58,324	68,743	73,223	105,467	131,745	104,654	41,603	25,538	14,079	21,098	669,686

* Customer is able to take deliveries thru SRP interconnect.
& Oct - Dec deliveries were made to individual farmers under excess contracts.
= Deliveries may include recharge/exchange water.
@ Oct & Nov deliveries were purchased from Hohokam.
! Dec deliveries were made to individual farmers under excess contracts.

FIGURE 1. OVERVIEW OF THE CENTRAL ARIZONA PROJECT.

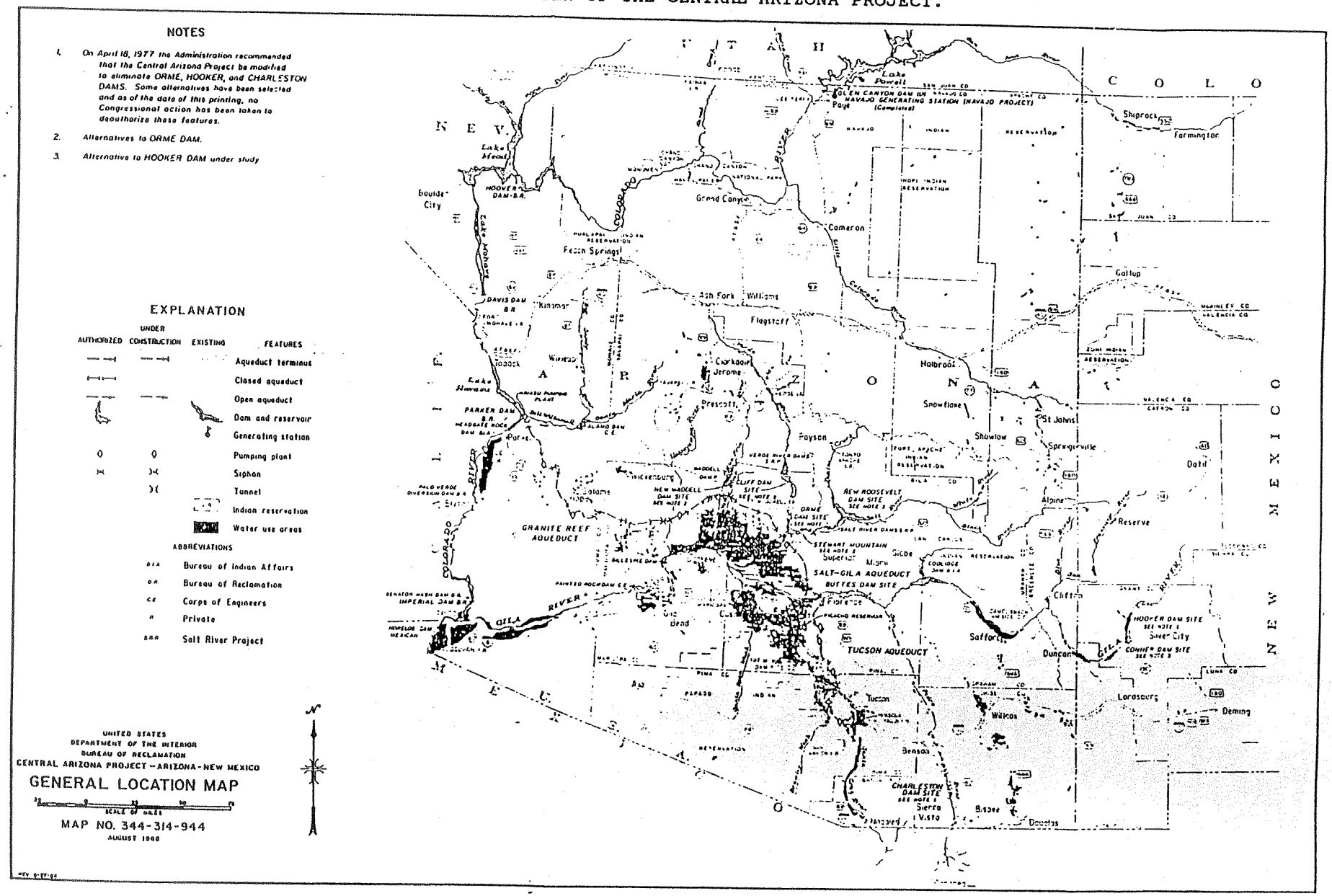
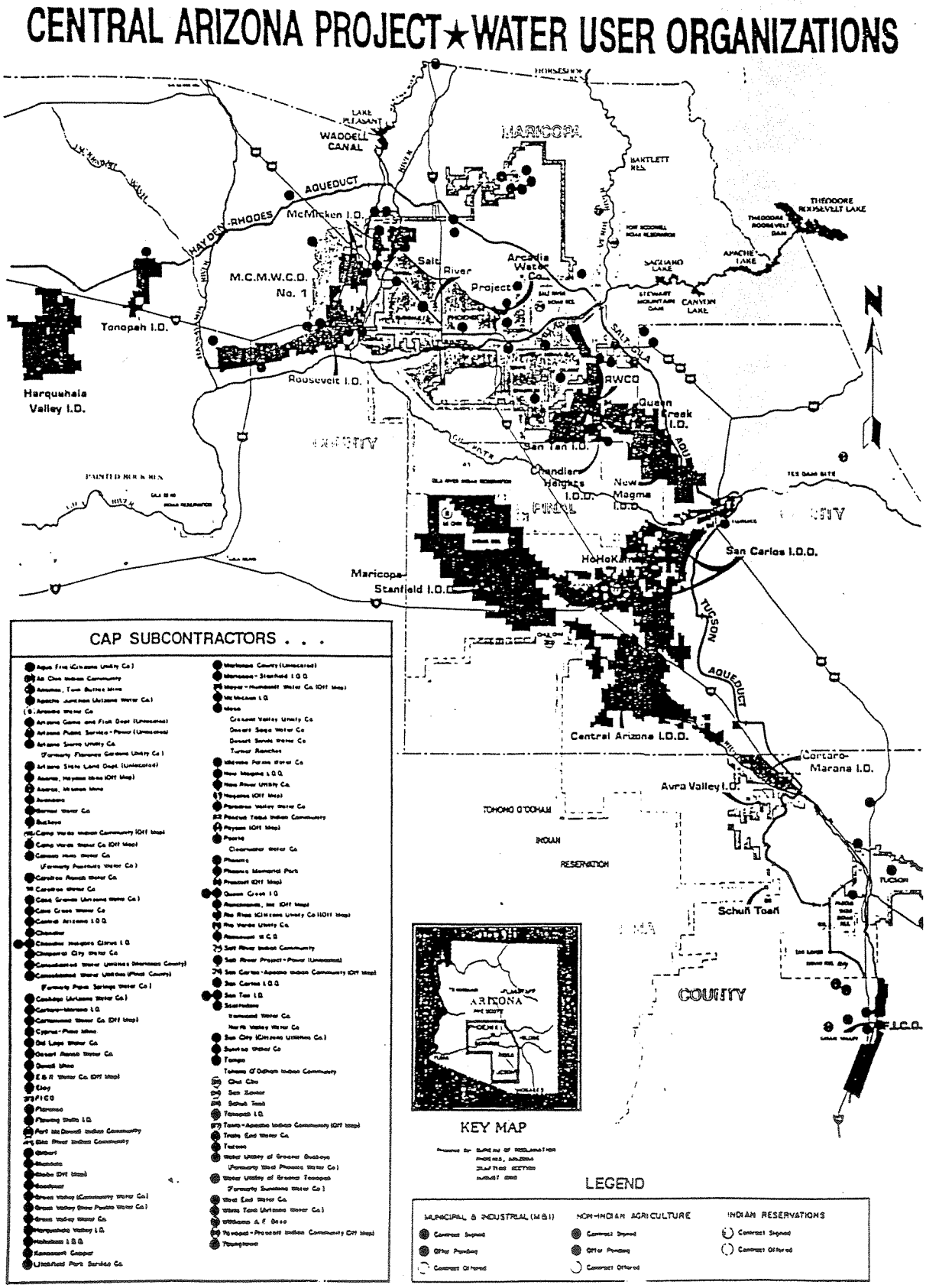


FIGURE 2. LOCATION OF CENTRAL ARIZONA PROJECT WATER USERS IN CENTRAL ARIZONA.



Salt and Verde Rivers

The CAP aqueduct crosses the Salt River below Granite Reef Dam which is below the confluence of the Salt and Verde Rivers.The two major Salt River Project (SRP) canals receive Salt and Verde River water from Granite Reef Dam and the diversion from CAP into those canals is located in the same general area (Figure 3). This water is for both municipal and agricultural uses. There are electric fish barriers on both the SRP canals upstream of the CAP delivery point to deter fish passage upstream into the Salt River above Granite Reef Dam. Upstream of Granite Reef are two large dams on the Verde River and four on the Salt River that provide further deterrence.

Gila River

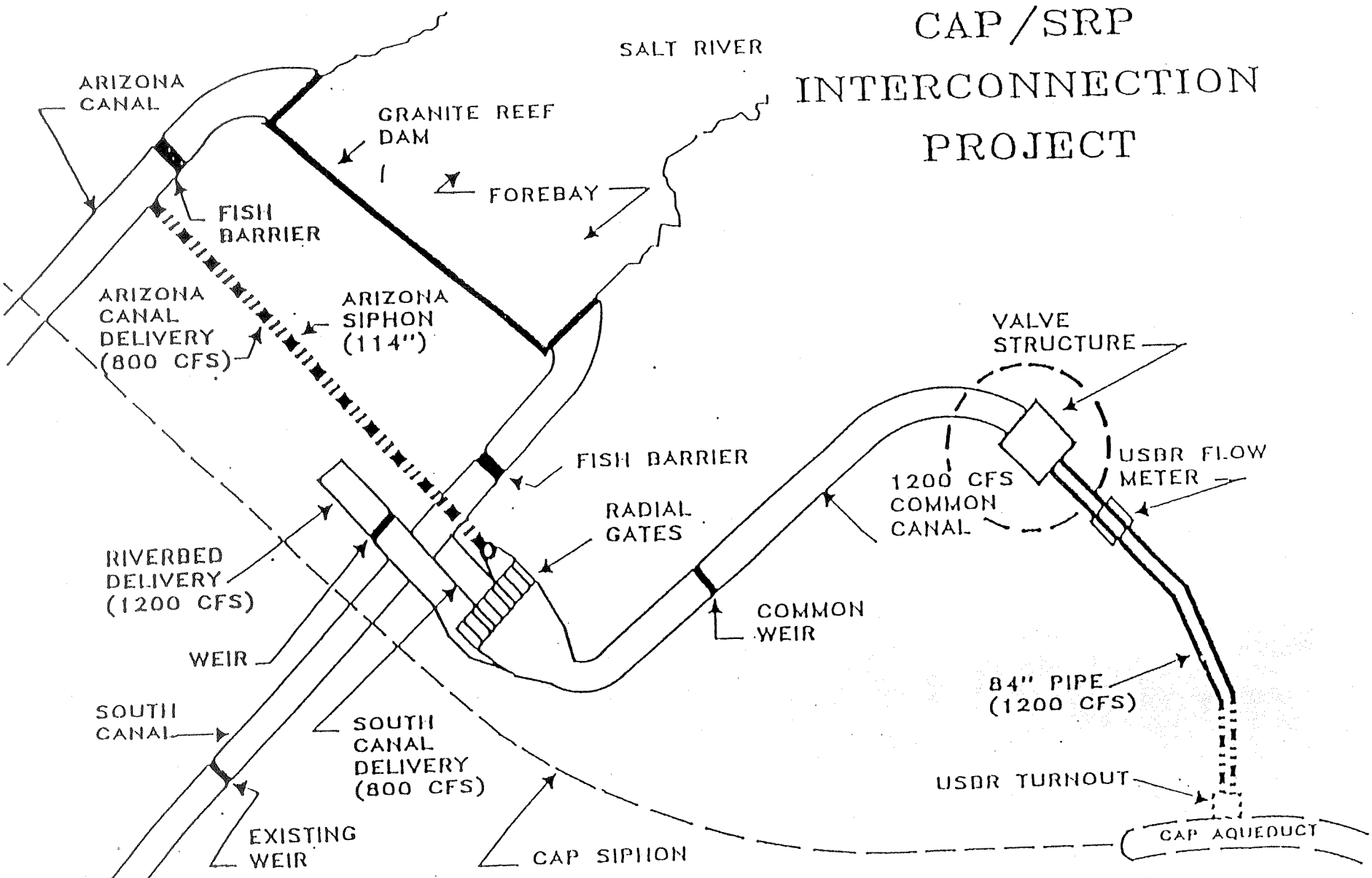
Water deliveries to the affected area from the CAP will be made from turnouts off the CAP aqueduct to the various irrigation districts and other users. There are 21 CAP water delivery turnouts on the CAP aqueduct between the Salt River siphon in Maricopa County and the Picacho Pumping Plant near Eloy in Pinal County. These turnouts serve water users in the area of the Gila River. Five of the turnouts are in the East Salt River Valley for delivery to primarily municipal water users.

For some of the irrigation districts, the connections to the Gila River channel are limited to return flows from their distribution systems that may reach the river channel, siphon crossings of the canals under the Gila River, or from canals or sumps that are in the 100 to 500 year floodplain of the Gila or smaller tributary streams. Some irrigation districts, such as Maricopa-Stanfield, Hohokam and Central Arizona, do not currently have a surface water source for their crops and use groundwater exclusively.

The presence of CAP water in the canals of the irrigation systems, coupled with the opportunity to reach the channel of the Gila River between its confluence with the Salt River and Ashurst-Hayden Diversion Dam, provides the potential for CAP transferred non-native fish species to move from the CAP to the Gila River channel. Although the Gila River is usually dry throughout this reach, there is water often enough in part or all of the channel to allow for the movement of fish upstream.

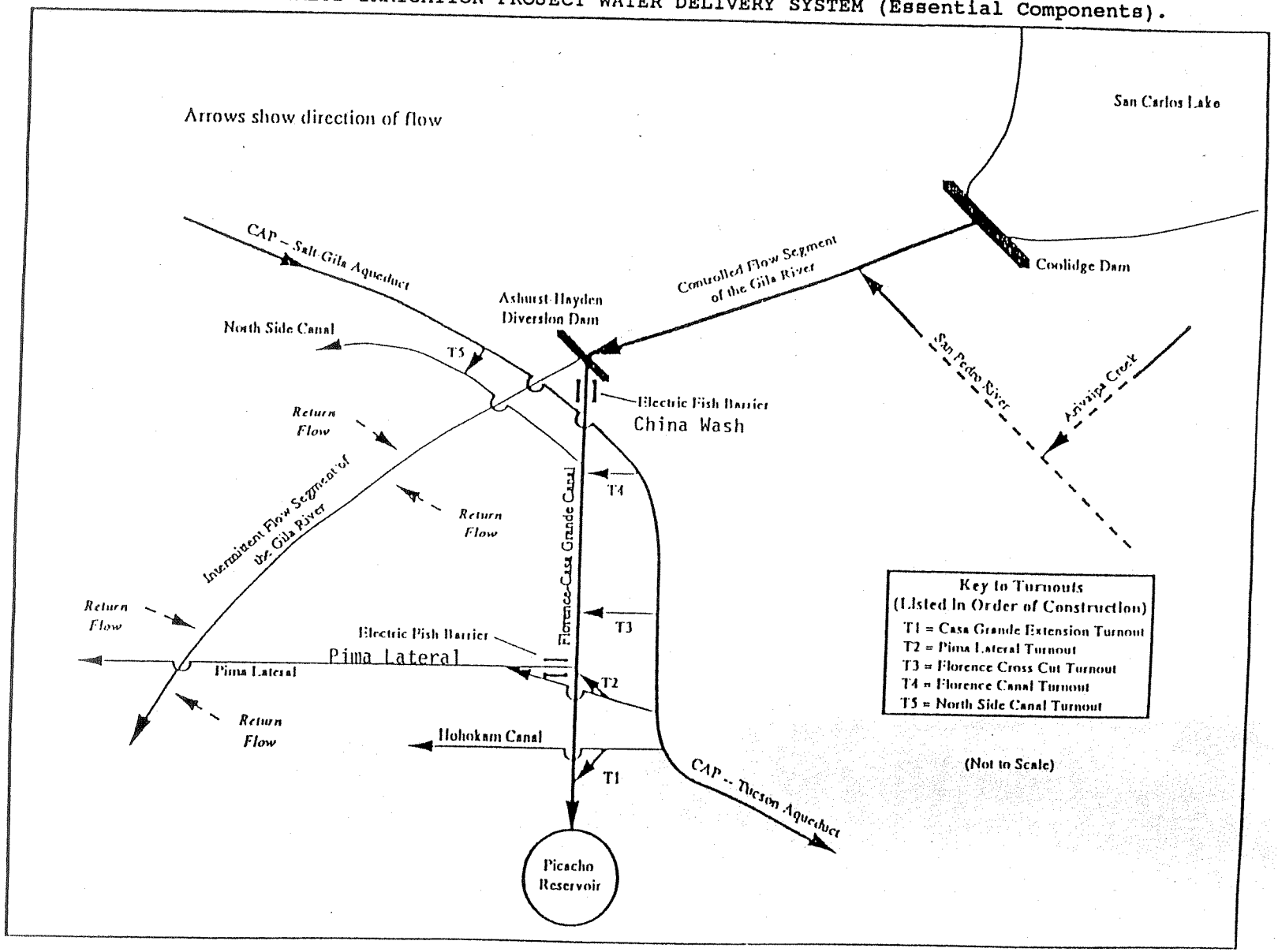
In addition to this indirect route, the San Carlos Irrigation Project (SCIP) also has a direct route for the transfer of fish species. Coolidge Dam, on the Gila River upstream of the CAP aqueduct crossing, is a water storage dam that supplies surface water from the Gila River to the two entities that comprise SCIP; the Gila River Indian Community (GRIC) and the San Carlos Irrigation and Drainage District (SCIDD). There are some farmers in SCIDD that are not within the SCIP portion of the district. Figure 4 shows the pertinent physical features of the existing irrigation system. Water is released from Coolidge Dam and flows past the confluence with the San Pedro to the Ashurst-Hayden Diversion Dam approximately 40 miles downstream. There the released flow is diverted south into the Florence-Casa Grande Canal. With the long irrigation season in Arizona, combined with bank storage in the Gila and natural flows from the San Pedro, the Gila River between Coolidge and Ashurst-Hayden Dams is largely perennial. Unless there has been a rainfall event or natural flows exceed the capacity of the Florence-Casa Grande Canal, the Gila River below Ashurst-Hayden is usually dry. In the winter when the SCIP is not irrigating, the inflow from the San Pedro River and runoff from rainfall

FIGURE 3. CENTRAL ARIZONA PROJECT/SALT RIVER PROJECT INTERCONNECTION



CAP Biological Opinion - April 15, 1994

FIGURE 4. SAN CARLOS IRRIGATION PROJECT WATER DELIVERY SYSTEM (Essential Components).



events may result in flow in the Gila River below Ashurst-Hayden since there would be no diversion of flow into the Florence-Casa Grande Canal.

The delivery of CAP water to SCIP is via a series of turnouts to the Florence-Casa Grande Canal to serve SCIDD lands or via the Pima Lateral Feeder Canal to serve GRIC lands. The first of the turnouts, the Pima Lateral Feeder Canal was constructed in 1989 to deliver CAP water into the existing Pima Lateral Canal (which connects to the Florence-Casa Grande Canal) in exchange for GRIC leaving 30,000 acre-feet of their SCIP water in San Carlos Reservoir to provide a minimum pool for the fishery. In 1990, other turnouts were proposed, and some constructed, from the CAP aqueduct and the Florence-Casa Grande Canal to serve SCIDD. There are, then, existing direct water connections from the CAP aqueduct to the Gila River above Ashurst-Hayden Dam via the Florence-Casa Grande Canal. There may also be instances where other irrigation districts canal systems are connected to the SCIDD system, thus providing an additional introduction point for CAP water and fish to reach the Florence-Casa Grande Canal.

Unlike the other irrigation districts in the area, the first water to SCIP entities was in 1990. The GRIC received 47,548 acre-feet of CAP water, up to 30,000 for their SCIP water left in San Carlos Reservoir, and the rest under an interim contract. The SCIDD received 10,301 acre-feet and SCIP as a separate entity received 24,483 acre-feet. In May 1991 an additional 5,020 acre-feet were delivered and no water has been delivered to these entities since that time. To protect against CAP fish introductions, two electric fish barriers were constructed to deter fish from moving upstream beyond the diversion at Ashurst-Hayden. The first was placed on the Pima Lateral to deter fish from accessing the Florence-Casa Grande Canal and was part of the GRIC exchange program. The second was placed on the Florence-Casa Grande Canal at the U.S. Geological Survey gaging station at China Wash, upstream of any CAP turnout to the Florence-Casa Grande Canal.

Summary

The waters conveyed by the CAP can connect both directly, via existing canals and reservoirs, or indirectly, via return flows, to the rivers of the Gila River basin. This connection opens potential conduits for the transfer of non-native species of fish to the lower Gila River basin tributaries and to the middle and upper Gila River basin above Ashurst-Hayden Dam. The Hassayampa, Agua Fria, Salt and Verde Rivers, as tributaries of the Gila, will also enable any fish species introduced into their waters from the CAP to reach the Gila River and eventually move upstream to the base of Ashurst-Hayden. Ashurst-Hayden Dam is not an effective fish barrier for several reasons, both structural and operational, and any fish species that reaches the base of the dam would have the opportunity to move beyond it to the middle Gila and San Pedro Rivers. The presence of the CAP connection creates a perennial waterway from the Colorado River to the major streams of the Gila River basin, connecting rivers and canal systems currently more isolated by dams and intermittent stream reaches.

EFFECTS OF THE ACTION

The introduction and spread of non-native fishes and other aquatic organisms have been identified as major factors in the decline of native fishes throughout North America and particularly in the southwest (Miller 1961, Lachner et al. 1970, Moyle 1976, Courtenay and Stauffer 1984, Williams et al. 1985). Miller et al. (1989) report that non-native species were the second most common causal factor in recent extinctions of North American fishes. Although not always the primary factor, non-native species played a part in 68

percent of the 40 known North American fish taxon extinctions in the past 100 years.

Interbasin water transfers have been implicated in the transfer of species and the fostering of non-native establishment (USDI BR 1990, Meador 1992). Although the CAP does moves water only within the Colorado River basin, it connects two disparate portions of that basin, which presently support different non-native fish faunas. The CAP provides increased access for non-native fish species in the Colorado River and upper basin into the Gila River basin.

In addition to direct transfer of non-native species from the Colorado River, the CAP provides a "highway" for the movement of non-native species within the Gila River basin. Historically, the rivers and streams of the Gila basin were perennially or intermittently connected by surface flow, allowing movement of fish throughout the system. With the advent of European settlement, water development and watershed use severed those connections with dams, reservoirs, and loss of surface flows. Although this fragmentation of their populations was detrimental to the survival of the native Gila basin fishes, it provided some benefits by inhibiting the spread of non-native species. With the completion of the CAP, the Gila basin rivers and streams will be reconnected by surface flow, once again increasing the opportunity for movement of fish throughout the system, this time with non-native species being a major component in the fish community of the basin.

Probabilities on which non-native species will be introduced via CAP and the timing of their introduction cannot be predicted; however, over the 100-year life of the CAP, the probability is high that one or more non-native fish species will use the CAP as an avenue to colonize habitats now occupied by listed fish species, and either alone, or in concert with other species or physical situations, have major adverse consequences to the listed fish. Critical habitats for spikedace and loach minnow in Aravaipa Creek, the upper Gila River, the upper Verde River, and the Blue and San Francisco Rivers will be adversely affected, as will critical habitats for the razorback sucker in the Verde, Salt, and Gila Rivers.

Environmental Baseline

Impact analysis for the proposed project must consider the already seriously deteriorated condition of the aquatic habitats and native fish community of the Gila River basin. Several native fish species have already been extirpated from the basin and others now occupy only limited areas. Of the 14 native fishes that remain in, or have been restocked into the Gila River basin, 86 percent are Federally-listed as endangered or threatened (8 species) or are Federal candidates (4 species). Only 2 species have no special status, although the paperwork is being processed to add both to the candidate list. Minckley and Douglas (1991) believe that the pattern of decline and extinction in western river basins is rapidly moving beyond the loss of individual fish species to a pattern of collapse of entire aquatic faunas.

The decline of the Gila River basin native fish community has resulted primarily from impoundment, diversion, channelization and other manipulations and alterations of the rivers, streams, and watersheds. Impoundments such as San Carlos, Roosevelt, and Horseshoe Reservoirs all directly removed habitat for most native species and modified or dried flows in long stretches downstream. Major portions of the Gila River system now flow only intermittently; e.g., the San Pedro River, the lower Salt River, and the Gila River near Virden, New Mexico, near Safford, Arizona, and below Ashurst-Hayden Dam. Habitat alteration has greatly reduced the complexity of the aquatic system. Alterations to the river system have created new types of habitats

more favorable to non-native species than to native species (Minckley 1983, Bestgen and Propst 1986, Bestgen and Propst 1989, Rinne 1991).

Introduction and spread of non-native fish species has also been a major factor in the decline of the Gila River basin fish community (Minckley and Deacon 1968, Meffe 1985, Minckley 1985, Propst et al. 1986, Propst et al. 1988, Propst and Bestgen 1991, Rinne 1991). The Gila River basin presently supports several non-native fish species. Some of these, such as rainbow trout (Oncorhynchus mykiss) (USDI FWS 1983, Propst et al. 1992), channel catfish (Ictalurus punctatus)(Bestgen and Propst 1989, Marsh and Brooks 1989), mosquitofish (Gambusia affinis) (Meffe et al. 1983, Meffe 1985), and smallmouth bass (Micropterus dolomieui) (Propst et al. 1986), have had substantial adverse impacts to the native fish species. A few, such as fathead minnow (Pimephales promelas), appear to have had little effect upon native fishes.

Thus, the pre-project baseline is a deteriorated system where native fishes persist in isolated stream sections which have not yet undergone sufficient perturbation to cause extirpation of those species. Non-native species already present exert continuing competitive and predatory pressure on native fishes. Fragmentation of aquatic habitats has disrupted historic patterns of recolonization or augmentation of damaged or destroyed native fish populations from intact up-stream or downstream populations. Additional impacts to these systems and the listed fish from the proposed project will be cumulative to the existing baseline. Therefore, project effects are of more consequence to the species than if the baseline was a pristine condition.

Analysis of Effects

1. Non-native Species Which Might be Introduced Through CAP

In an attempt to define the extent of the potential problem, the striped bass (Morone saxatilis), white bass (Morone chrysops), blue tilapia (Tilapia aurea), rainbow smelt (Osmerus mordax), and the triploid grass carp (Ctenopharyngodon idella) were identified in early planning for CAP water deliveries as being non-native fish that were likely be transported by CAP and to adversely impact the native fish species of the Gila drainage.

Matter (1991) evaluated the five species for their likelihood of entry and survival in the Gila River above Ashurst-Hayden Dam. These five species are not currently found in the Gila River basin above Ashurst-Hayden, but all are currently found in the Colorado River system. All five are believed to have adverse effects on native southwestern fishes (Taylor et al. 1984; Evans and Loftus 1987; Miller and Fuiman 1987; W.L. Minckley, Arizona State University, pers. com., April 1991).

In addition to those five species, we are also concerned about other non-native fish which already inhabit the Colorado and Gila Rivers and the CAP aqueduct system, or which may at some time be introduced into those systems. Such species fall into three categories: those already known and perhaps established in the Colorado River or CAP systems, but not yet in the middle or upper Gila River basin; those not yet found in the Colorado River system, including the Gila River basin; and those already found throughout most of the Colorado and Gila River basins. The CAP and interconnecting canal systems provide enhanced opportunities for such non-natives to colonize, recolonize, or augment existing populations in the Gila River basin. Because of the size and habitat characteristics of the streams of the Gila River basin, it is likely that the primary threat from non-native fish incursion may come from some of the smaller non-native fish species, rather than the larger species included in Matter's study.

Non-native fishes already known and perhaps established in the Colorado River system, but which have not yet successfully invaded the middle or upper areas of the Gila River basin, include the guppy (Poecilia reticulata), golden shiner (Notemigonus crysoleucas), sailfin molly (Poecilia latipinna), redside shiner (Richardsonius balteatus), and plains killifish (Fundulus zebrinus) (Minckley 1973, Hughes 1981, Haynes et al. 1982) Non-native fishes which have been reported from the CAP and interconnected Salt River Project (SRP) canals include: threadfin shad (Dorosoma petenense), rainbow trout, brook trout (Salvelinus fontinalis), goldfish (Carassius auratus), common carp (Cyprinus carpio), grass carp-bighead carp hybrids (Ctenopharyngodon idella x Aristichthys nobilis), golden shiner, red shiner (Cyprinella lutrensis), beautiful shiner (Cyprinella formosa), fathead minnow, black bullhead (Ameiurus melas), yellow bullhead (Ameiurus natalis), channel catfish, flathead catfish (Pylodictis olivaris), mosquitofish, sailfin molly, guppy, shortfin molly (Poecilia mexicana), swordtail (Xiphophorus variatus), yellow bass (Morone mississippiensis), striped bass, green sunfish (Lepomis cyanellus), bluegill (Lepomis macrochirus), redear sunfish (Lepomis microlophus), convict cichlid (Cichlasoma nigrofasciatum), firemouth cichlid (Cichlasoma meeki), Rio Grande cichlid (Cichlasoma cyanoqutattum), largemouth bass (Micropterus salmoides), black crappie (Pomoxis nigromaculatus), walleye (Stizostedion vitreum), blue tilapia, Mozambique tilapia (Tilapia mossambica), and redbelly tilapia (Tilapia zilli) (Marsh and Minckley 1982, Mueller 1989, Matter 1991). The thriving non-native fish fauna of these canals illustrates their potential as a source from which non-native fish could move into the Gila River system.

Predicting the species of non-native fishes not presently established in the Colorado River system that will be introduced via CAP, and their potential for threat to native species, is, of course, impossible. However, certain groups or species have a higher probability than others of entering that category. Examples of fish species which are expanding their ranges in the United States, either by migration or human transfer, and which have some likelihood of spreading into the Colorado and Gila River systems include the rudd (Scardinius erythrophthalmus), sheepshead minnow (Cyprinodon variegatus), gizzard shad (Dorosoma cepedianum), bigscale logperch (Percina macrolepida), tench (Tinca tinca), silver carp (Hypophthalmichthys molitrix), bighead carp (Aristichthys nobilis), and pacu (Colossoma sp.) (Moyle 1976; Robins et al. 1980; Courtenay et al. 1984; Platania 1990; Howells et al. 1991; J. Brooks, U.S. FWS, Dexter, NM pers. com. April 1991; J. Williams, U.S. FWS, Gainesville, FL, pers. com. April 1991; Univ. of Arizona 1993). A thorough literature search would likely turn up more, most of which can be expected to have some adverse impacts to native fish species. Various aquarium fishes have been documented as causing adverse effects to native southwestern fish species (Courtenay and Deacon 1983, Courtenay et al. 1985, Deacon et al. 1964). Unauthorized dumping of unwanted aquarium fish into canals, springs, and rivers is a continuing source of non-native introductions and is the likely source of a number of the small non-native fishes in the Phoenix-area canals (Lachner et al. 1970, Marsh and Minckley 1982, Williams and Sada 1985, Courtenay and Meffe 1989). It is likely that common aquarium species in the families Poeciliidae, Characidae, Loricariidae, Cobitidae, and Cichlidae would pose threats to most of the small native fishes and to young of the larger natives.

Augmentation, through CAP, of populations of non-native species already introduced into the Gila River basin may increase the adverse effects those species exert on the native fishes. Continuing introduction of additional individuals of a non-native species may help that population reach higher levels and buffer it against the effects of natural events such as flooding and drought. Controlling non-native populations through management becomes

increasingly difficult when the population is continuously augmented from outside.

Although non-native fish are the primary concern in this analysis, the proposed project will also provide an avenue for introduction of other non-native aquatic organisms into the Gila River basin. Various insects, molluscs, crustaceans, plants, and parasitic and disease organisms may be transported into the Gila River basin via the CAP and may have adverse effects on the ecosystem as a whole as well as on the listed fishes specifically. While effects of past non-native invertebrate introductions on native southwestern fishes and invertebrates are poorly documented, such species as the Asian clam (Corbicula manilensis) and the crayfish (Procamberus clarkii) have been implicated in declines of native species (Pister 1979, Wells et al. 1983). Asian tapeworm (Bothriocephalus acheilognathi) contributed to recent declines of the woundfin (Plagopterus argentissimus) in the Virgin River. The tapeworm is thought to have entered the Virgin River with invading red shiner (Heckmann et al. 1986). It is anticipated that other invertebrate non-natives currently expanding their range, such as the zebra mussel (Dreissena polymorpha) and giant rams-horn snail (Marisa cornuarietis) would have adverse effects to native fishes and invertebrates (USDI BR 1990, Horne et al. 1992).

2. The Time Frame of Project Effects

It is important to understand that the CAP is not a project whose impact can be measured over a short span of years. Once constructed and operational, the aqueduct system will be bringing water from the Colorado River into the Gila River basin for at least 100 years. Delivery of that water to users gives any species which enters the aqueduct during the period of operation continuous access into the Gila River basin. Once established in the Gila basin, the effects of non-native species on native species will continue far beyond the life of the project. Proper analysis of the potential impacts of the proposed project must include a long-term view since the longer CAP is in operation, the higher the risk of undesirable non-native species entering the system. With the aqueduct and the proposed and ongoing water deliveries, the risks of non-native species reaching the habitat of the listed species are clearly increased and continue long past the construction phase of any feature of the CAP.

3. Potential Sources of CAP-associated Non-native Introductions

There are several avenues by which non-native species may enter the CAP aqueduct. The most direct entry point for non-native species into the CAP aqueduct is from Lake Havasu at the aqueduct head on the Colorado River. This route has been documented as the source of nine species of non-native fish currently present in the CAP aqueduct (Mueller 1989). Non-native species will also be able to enter the aqueduct through Lake Pleasant. Tilapia and white bass are both likely to enter the aqueduct from Lake Pleasant (Matter 1991). Other points of entry are discussed in the project description section above.

Non-native species may also enter the CAP through accidental or intentional release by private citizens without authorization; also known as "bait bucket" introductions. The increasing interconnection of waters of the Colorado River basin through canals and aqueducts adds increasing opportunities for this type of introduction. Increased opportunity for bait bucket introductions was also noted as an important concern in environmental analyses for the Garrison Diversion Unit in North Dakota, an interbasin water transfer project similar to CAP (USDI BR 1990a). CAP provides increased opportunity for spread of bait bucket introductions through much larger portions of the basin than would be possible via the natural stream systems. Bait bucket introductions are made for many reasons: stocking of favorite sport fish, escape or dumping of bait,

dumping of unwanted aquarium or pet fish, or escape of aquaculture species. The proximity of CAP and interconnected SRP canals to high-density human populations in the Phoenix-Tucson area and the easy availability of CAP and SRP canals to anglers and other people, all combine to make CAP and SRP waters a prime source for bait bucket introductions. Several species already found in the CAP aqueduct are thought to have entered via bait bucket transfer (Mueller 1989). The CAP aqueduct also passes close to Picacho Reservoir, a heavily used fishing site between Phoenix and Tucson. Picacho Reservoir is fed by Gila River water via the Florence-Casa Grande Canal. Sites such as this with close proximity to Gila River and Colorado River (CAP) water, both offering legal or illegal fishing opportunities, tempt anglers to stock one with fish from the other or to dump bait obtained from one into the other. Anglers are often involved in the transport and introduction of fish species from one water to another, either deliberately or through casual release of bait fish (Minckley 1973, Bestgen et al. 1989). While bait bucket introductions will occur with or without the CAP, CAP will provide an increased opportunity for such introductions and will allow introduced species a much greater opportunity to spread throughout the Gila River basin.

4. Sub-basins - Potential Effects

A. Hassayampa River. The potential route from CAP into listed fish habitats in the Hassayampa River is through irrigation diversions in the Harquahala Valley, lower Hassayampa River basin, and Gila River near the mouth of the Hassayampa River. Species released into the Harquahala Valley could move downstream in Centennial Wash into the Gila River and upstream into the Hassayampa River. The Gila River normally has flowing water in this area due to effluent from Phoenix. Painted Rock Reservoir, a few miles downstream from Centennial Wash and the Hassayampa River mouths, is a likely harbor for invading CAP non-natives. Non-native species which become established in Painted Rock Reservoir serve as a constant source for upstream movement during periods of flow in the rivers.

The listed fish present in the Hassayampa River basin include stocked populations of desert pupfish, Gila topminnow, and Colorado squawfish in springs and ponds at The Nature Conservancy Hassayampa Preserve and stocked populations of Gila topminnow in isolated springs in the upper watershed. In addition, a reach of the Hassayampa River near Wagoner has been designated as habitat for establishment of an experimental, nonessential population of woundfin.

The probability of CAP introduction of non-native species into the Hassayampa River basin is moderate to high and the consequences to listed species will be moderately adverse. The probability is moderated by long, normally dry, stream stretches. Although the populations of listed species in the Hassayampa River basin are small, the perennial waters of the Hassayampa basin are important recovery habitat.

B. Agua Fria River. Fish movement from the CAP aqueduct into Lake Pleasant and up into the Agua Fria River will be unrestricted. Prior to the first CAP water entering Lake Pleasant in December 1992, striped bass were present in the CAP aqueduct, but were not known from the lake. In November 1993, less than a year later, the first recorded striped bass were caught in the lake. Lake Pleasant will periodically spill excess flood water downstream, thus allowing non-native species to move downstream to the Gila River.

As a result of an earlier biological opinion, a barrier has been constructed by BR on Tule Creek, a tributary of the Agua Fria which supports a large stocked population of Gila topminnow. Several other stocked Gila topminnow

populations are present in the basin and a bald eagle nest is located at Lake Pleasant.

Introduction of non-native species into the Agua Fria River basin via CAP is virtually certain and the consequences to listed species will be moderate. The planned fish barrier on Tule Creek will provide some protection to the Tule Creek Gila topminnow population, although the presence of non-native species near the downstream side of the barrier will raise the probability of bait bucket transfer above the barrier. Cow Creek and Humbug Creek, both of which have stocked Gila topminnow populations, already support several non-native species. The Gila topminnow populations in those creeks will probably succumb to increased non-native pressure over the life of the CAP.

C. Salt and Verde Rivers. Because the entry point for CAP-assisted non-native species is below the confluence of the Salt and Verde Rivers, the effects on these two river basins are closely related. The potential entry point is at the interconnection of the CAP and SRP systems near Granite Reef Dam on the Salt River (Figure 3). The two major SRP canals head in the pool behind Granite Reef Dam (the forebay). CAP water is transferred from the aqueduct into the canals just downstream from their head. Non-native species could move out of the CAP aqueduct into the SRP canals and from there move upstream into the Salt River above Granite Reef Dam.

The listed species present in the Verde and Salt River basins include bald eagle, spikedace, loach minnow, stocked razorback sucker, stocked Colorado squawfish, and numerous stocked Gila topminnow populations, mostly in isolated springs and small streams. Critical habitat for spikedace is located in the Verde River between Sullivan Dam and Sycamore Creek. Critical habitat for razorback sucker is located in the Verde River between Perkinsville and Horseshoe Dam. In the Salt River, critical habitat for razorback sucker is located between U.S. Highway 60/State Route 77 and the Roosevelt Diversion Dam.

The probability of CAP introduction of non-native species into habitats of the listed species in the Salt and Verde River basins is low, but the consequences of such introductions to the listed species are severe. The probability of upstream movement of fish or other aquatic organisms is limited by several structures. On the Salt River, these structures include the two electric barriers on the SRP canals, which prevent or hinder upstream movement from the canals; Granite Reef Dam, which serves as a barrier to upstream movement in the Salt River bed; and Stewart Mountain, Mormon Flat, Horse Mesa, and Roosevelt Dams, which block fish movement on the Salt River between Granite Reef Dam and the native fish habitat in the upper basin. On the Verde River, fish which surmount Granite Reef Dam are then blocked by Bartlett and Horseshoe Dams from reaching the portions of the river occupied by listed fish.

Despite these barriers, non-native species continue to spread upstream, most likely by bait bucket transport. The presence of CAP introduced non-natives at the base of any given dam increases the risk of those non-natives being transported upstream into the reservoir and river. The electric fish barriers, both on the SRP canals and the Florence-Casa Grande and Pima Lateral Canals (see D. below), are not totally effective at preventing upstream fish movement. Little data exist to support the assumption that these electric barriers totally block upstream fish movement and some ichthyologists have expressed the belief that fish can move upstream through the barriers under certain conditions. In addition, electric barriers are subject to periodic operational failures, such as the one occurring at the SRP barriers on December 23, 1993 (SRP 1994). Following that barrier outage, two grass carp, formerly found only below the barrier, were captured upstream of the barrier.

It is not known how many other individuals of this and other fish species may also have crossed the barrier during the outage. An outage also occurred at the Pima Lateral electric barrier in June 1990 (USDI BR 1990b).

The importance of the listed fish populations in the Salt and Verde River is high. One-third of the known remaining occupied spikedace habitat is in the upper Verde River. One of five remaining loach minnow populations is found in the White River in the upper Salt River basin. Loss of these populations will seriously damage the survival potential of either species. The reestablishment of razorback sucker and Colorado squawfish in the Salt and Verde River basins have had only limited success due to non-native fish predation (Marsh and Brooks 1989). Addition of more species of non-natives could preclude recovery of both listed fish in these rivers.

D. Gila River below Coolidge Dam and San Pedro River. There are numerous entry points into the Gila River itself, as discussed in the project description. The entry point of highest concern is the Florence-Casa Grande Canal, which begins at the pool behind Ashurst-Hayden Dam. Due to various structural features, Ashurst-Hayden Dam is not an effective barrier to upstream fish movement, and ceases to be a barrier at all when the river-level gate is open. No barrier to upstream fish movement exists in the Gila River above Ashurst-Hayden and below Coolidge Dam. Non-native species which enter the Gila River in that area also have open access to the San Pedro River system, including Aravaipa and Redfield Creeks, and the Babocomari River. Matter (1991) has concluded that four of the five non-native fishes considered in his study would likely spread into those areas given the proposed project, even with the existing electric barriers on the Pima Lateral and Florence-Casa Grande Canals.

The portion of the Gila River basin where native fish species are most at risk is the Gila River between Ashurst-Hayden and Coolidge Dams and the San Pedro River and its tributaries. The potential consequences of those introductions to the listed species are severe. This area includes a bald eagle nest at Coolidge Dam and spikedace and loach minnow in Aravaipa Creek. A recent spikedace record in the Gila River near Cochran (about 7 miles above Ashurst-Hayden Dam) suggests that spikedace may also still inhabit portions of the Gila River between Ashurst-Hayden and Coolidge Dams (USDI BR 1992). Important recovery habitat for spikedace, loach minnow, razorback sucker, desert pupfish, Gila topminnow, and other native fish exists in the upper San Pedro River basin (Stefferud and Stefferud 1989).

Matter (1991) specifically analyzed the potential of five species of non-native fish which might be introduced by CAP into the Gila River basin below Coolidge Dam. He concluded that although four of the five non-natives are likely to move throughout the Gila and San Pedro Rivers, all have a low probability of reproducing in habitats currently occupied by spikedace, loach minnow, and razorback sucker. Only the blue tilapia is considered likely to be able to reproduce in the San Pedro River or its tributaries, including Aravaipa Creek. Blue tilapia are mouthbrooders and utilize a variety of food resources including both phyto- and zooplankton, benthic invertebrates, detritus, and algae (Drenner et al. 1984 In Matter 1991). This diet overlaps with the insect diet of both spikedace and loach minnow (Minckley 1973, Propst et al. 1986, Propst et al. 1988, Marsh et al. 1989) and in juvenile fish there may be more of an overlap due to the small sizes of prey required. Some authors found that eggs and larvae are also possibly part of the diet of blue tilapia (Shaflund and Pestrak 1983 In Matter 1991). While blue tilapia do not nest, they have been known to harass other fish and interfere with native fish reproduction. Harassment may be a less significant factor for spikedace than for loach minnow. Spikedace releases eggs into the water column (Barber et al. 1970). Loach minnow males may provide some care of the eggs (Propst et

al. 1988). We know of no data on the effects of blue tilapia on native Gila River basin fishes, but redbelly tilapia have been shown to replace desert pupfish in areas of the lower Colorado River basin (Schoenherr 1981).

Matter (1991) did not consider rainbow smelt likely to spread into the Gila River above Ashurst-Hayden Dam, and therefore not likely to affect native fishes in the middle and upper Gila basin. He believed grass carp may reach the Gila River above Ashurst-Hayden but did not consider them likely to move into the San Pedro or the smaller tributaries. Therefore, he believed them unlikely to pose any significant problems for the listed fish.

With the proposed project, both white and striped bass will likely become a part of the fish fauna in the Gila and San Pedro Rivers and their tributaries (Matter 1991). Although not likely to reproduce in the Ashurst-Hayden to Coolidge Dam reach, these species are likely to prey on native and non-native fish species in those areas. The effects of these predators, contingent upon their density, could be significant upon the prey populations which would include spikedace, loach minnow, and razorback sucker.

E. Gila River above Coolidge Dam. There is less likelihood of CAP-mediated non-native introductions into the Gila River and its tributaries above Coolidge Dam. However, the consequences of introductions into that area are the most severe. The largest remaining populations of spikedace and loach minnow are found in the upper Gila, San Francisco, and Blue Rivers along with the largest portions of their critical habitat. Spikedace are also found in Eagle Creek. Several stocked razorback sucker populations are located in this portion of the basin and critical habitat for razorback sucker includes the area between the Arizona-New Mexico border and Coolidge Dam. Natural Gila topminnow populations are found in three springs on the Gila River alluvial plain near the town of Bylas, and stocked populations of Gila topminnow and desert pupfish are scattered throughout the basin. The Gila River between the mouth of the San Francisco River and the Safford Valley is considered to be of high value for recovery of razorback sucker, loach minnow, spikedace, and bonytail chub (Gila elegans) (Minckley 1985). The Gila River between San Carlos Reservoir and the Arizona-New Mexico border and the San Francisco River from its mouth to the Arizona-New Mexico border have been designated as habitat for establishment of experimental, non-essential populations of woundfin.

Transfer of non-natives over Coolidge Dam would not result directly from CAP, but, in conjunction with bait bucket transfer, will become substantially more likely as a result of the CAP introduction of non-natives into the Gila River below the dam. Coolidge Dam impounds San Carlos Reservoir which supports a warm water sport fishery that is heavily used by local and visiting anglers. A likely scenario for transport of fish from the dam base into the reservoir would be an angler driving to the river just below the dam to collect bait fish for use in the reservoir, then dumping excess bait into the reservoir. Once released into the reservoir, the risk of those non-native species spreading into the upper Gila, San Francisco, and Blue Rivers and their tributaries becomes quite high.

5. **Listed Species - Potential Effects**

For all non-native introductions, some common principles hold. Aquatic systems can support only a finite biologic resource. With each new species, regardless of the size of its population in the system, there are fewer resources to divide among the other species present. Long-term interactions of introduced and native fish populations are not simple to model or predict, but the record clearly indicates that introduction of non-native fishes into southwestern aquatic habitats coincides with reduction or elimination of

native fishes from those habitats. The mechanisms of this replacement are poorly understood and may include competition, predation, harassment, hybridization, usurpation of habitat, or alteration of habitat by the non-natives. Other factors, such as human-caused alteration in aquatic habitat from conditions more suitable to native fishes to conditions more favorable to non-native species, may also play an important role (Meffe 1983, Meffe 1985, Bestgen and Propst 1986, Marsh et al. 1989, Marsh and Brooks 1989, Baltz and Moyle 1993). Many existing Gila River basin native fish populations now coexist with one or more non-native fish species (Minckley 1973, Minckley 1983, Propst et al. 1986, Propst et al. 1988, Propst and Bestgen 1991, Rinne 1991). However, the long-term stability and eventual outcome of those situations are not yet known and may be altered by the cumulative impacts of additional non-natives.

Species-specific analysis of the likelihood of non-native species entering and successfully establishing in the Gila River basin, and the potential for impacts to each listed species, would be lengthy, complex, and largely non-productive. Too many unknown variables exist: which species, where they will enter, how many successive introductions will occur and what the short-term water conditions (i.e. drought, flood) will be at the time of introduction. In addition, species introduced into habitats outside their native range often act in ways quite different than within their native range. Once released from limiting pressures under which they evolved, species may adapt to conditions which had previously been thought to be unsuitable for them (Stauffer 1984, Brown and Coon 1991).

Most of the species which we have identified as having potential for introduction into the Gila River basin via the CAP connection have never co-occurred with the listed species of concern in this opinion. Therefore, no data exist on their interactions. However, many of those non-natives have been identified as being detrimental to other native southwestern fishes. Sailfin mollies have been identified as causing adverse impacts to desert pupfish (Matsui 1981, Schoenherr 1988), golden shiner to Little Colorado spinedace (Lepidomeda vittata) (Minckley and Carufel 1967), shortfin mollies to Hiko White River springfish (Crenichthys baileyi grandis) (Courtenay et al. 1985), redbelly tilapia to desert pupfish (Matsui 1981, Schoenherr 1988), sheepshead minnow to Pecos pupfish (Cyprinodon pecosensis) (Echelle and Connor 1989), redside shiner to woundfin (Minckley 1973), and grass carp to aquatic habitats in general (Taylor et al. 1984).

The cumulative aspect of effects of non-native introductions via CAP is an important factor in this analysis. Introduction of a non-native species through the CAP connection will likely not be a one-time-only event. Over the life of the project multiple "stockings" of each non-native species into the river basin will likely occur, thus substantially raising the probability of establishment. The multiple or continuous introduction of individuals of each non-native species into the Gila River system will not be the only long-term cumulative effect. Impacts to native fish from non-natives which make their way into the Gila River and its tributaries, whether via CAP or another route, may be additive, multiplicative, or synergistic. The effects of any given non-native fish on the listed fish may be tolerable in the absence of other non-natives. However, in the presence of other non-natives, those effects may result in serious losses to the listed species. Analyses of potential effects of a non-native species on native species must not be limited to one-on-one interactions, but must also consider community interactions.

Because of the continuous opportunity for movement of non-natives from the aqueduct into the river system, adverse effects to native species would not even necessarily require successful reproduction of the non-natives in the Gila River or its tributaries. Successful reproduction of a non-native

species in the CAP aqueduct or irrigation canals, combined with continuous movement into the river system, may give the non-native species an advantage over native species by insulating the non-native from the effects of limiting natural events, such as drought and floods.

A. Spikedace and Loach Minnow. Analysis of the effects of non-native introductions via CAP on spikedace and loach minnow must take into account the short life span of these fish; both survive only about two years. This makes both of these species particularly vulnerable to short-lived, high-intensity impacts. Loss of two consecutive years of reproduction in either spikedace or loach minnow would result in extirpation of the population. Both could sustain serious adverse impacts from invasion of their habitat by a non-native species even if the non-native fails to become established in the long-term.

Introduction of non-natives via CAP has the potential to affect all remaining populations of spikedace and loach minnow. The threat to the Verde River population of spikedace and the White Mountain population of loach minnow is low, due to protection provided by intervening dams. The Aravaipa Creek population of both loach minnow and spikedace will be at high risk and will probably be extirpated by cumulative impacts of non-native introductions over the life of the project. The upper Gila River and Eagle Creek populations of spikedace and San Francisco, Blue, and upper Gila River populations of loach minnow will probably suffer substantial losses due to CAP-mediated non-native introductions over the life of the project.

Proposed critical habitat for both spikedace and loach minnow includes Aravaipa Creek in Pinal and Graham Counties, Arizona and portions of the upper Gila River in Grant and Catron Counties, New Mexico. For loach minnow, proposed critical habitat also includes the Blue River and the San Francisco River for a stretch downstream from the mouth of the Blue in Greenlee County, Arizona, as well as portions of the San Francisco and Tularosa Rivers in Catron County, New Mexico. For spikedace, proposed critical habitat also includes the upper Verde River in Yavapai County, Arizona. Of these areas, Aravaipa Creek will clearly be affected by non-native introductions resulting from the CAP aqueduct. The Blue, San Francisco, Tularosa, and upper Gila Rivers will be affected by non-native species which may be transported over the dam into San Carlos Reservoir. The upper Verde may be affected by non-natives which eventually are transported above both mainstem dams on that river. Adverse modification of critical habitat is defined as a direct or indirect alteration that appreciably diminishes the value of the critical habitat for both survival and recovery of the listed species. The introduction of additional non-native fish species into the already degraded habitat of the spikedace and loach minnow will appreciably diminish the survival and recovery value of their critical habitats.

B. Gila Topminnow. Gila topminnow are particularly vulnerable to adverse impacts from non-native fish (Meffe et al. 1983). The springs near Bylas which support natural populations of Gila topminnow are separated from the Gila River only by short, dry, stream stretches. Mosquitofish have invaded those springs from the Gila River during periods of high flow. Barriers which have been constructed to exclude non-native fish from the springs are only partially successful and are too low to prevent invasion by some species. Introduction of additional non-native species into the Gila River above Coolidge Dam will substantially increase the threat of loss of these Gila topminnow populations.

The Cow Creek and Humbug Creek stocked Gila topminnow populations will probably be extirpated by cumulative non-native introductions over the life of the CAP. The Tule Creek population may survive if the barrier being constructed on that creek successfully prevents upstream movement of non-

native fishes. Other Gila topminnow stocked populations are in isolated springs or small perennial stream segments separated from the mainstreams by extensive areas of dry streambed. Some effects to these populations may occur through some upstream movement of non-natives and through increased opportunity for bait bucket introductions.

C. Desert Pupfish. Desert pupfish populations which may be affected by CAP non-native introductions into the Gila River basin (excluding the Santa Cruz River basin) are small, stocked populations, most of which are located in springs or short perennial portions of small streams generally isolated from the mainstream rivers. Effects on the desert pupfish from this project are expected to be minor.

D. Razorback Sucker. The 1991 listing of the razorback sucker extended the protection of the Act to all populations of the species, including those restocked into the Gila River basin. The success of that stocking effort has not been fully determined; however, monitoring of the ten year stocking effort indicates that the razorback suckers do not survive well in the presence of non-native fish populations (Marsh and Brooks 1989, Minckley et al. 1991). The combined effects of existing non-native fishes in the Gila River basin and non-native species which will be introduced via the CAP will most likely prevent successful reestablishment of razorback sucker in the Verde, Salt, and Gila Rivers.

Critical habitat for the razorback sucker includes the following areas in the Gila River basin: the Gila River from the Arizona-New Mexico border to Coolidge Dam in Graham, Greenlee, and Pinal Counties, Arizona; the Salt River from the old U.S. Highway 60/State Route 77 bridge to the Roosevelt Diversion Dam in Gila County; and the Verde River from Perkinsville to Horseshoe Dam in Yavapai County. These areas may be affected by non-natives which are eventually transported above the dams on those rivers. Introduction of non-native fish species into these habitats has already had a substantial adverse impact on the razorback sucker and additional introductions would appreciably diminish the value of the critical habitat for survival and recovery of the razorback sucker.

E. Colorado Squawfish. The stocked populations of Colorado squawfish in the Salt and Verde River basins are designated as experimental, nonessential. As such, loss of those populations cannot, by definition, result in jeopardy to the survival of the species. As with razorback sucker, the combined effects of existing and additional non-native species are expected to severely limit the successful reestablishment of Colorado squawfish in the Gila River basin.

F. Bald Eagle. The bald eagle feeds primarily on fish, utilizing suckers, catfish, and carp, as well as other available species in its daily diet (USDI FWS 1982). The introduction of non-native fish via the CAP has the potential to change the fish fauna of the Gila River basin, and thus the forage base for the southwestern population of the bald eagle.

The five fish species studied by Matter (1991) are, except for the rainbow smelt, hypothesized to be able to survive in the Gila River below Coolidge Dam. Only the blue tilapia was thought likely to reproduce and become a significant part of the fish fauna. If they become established, tilapia may force out some of the existing fish population, but their intolerance to cold may make them susceptible to bald eagle foraging as they concentrate in warmer, shallower waters. Small to moderate size grass carp may also be taken by bald eagles. Both white bass and striped bass prey on other fish and may thus have an adverse impact on the prey base of the bald eagle. The extent to which this is likely to affect the hunting opportunities for the bald eagle

nesting territory at Coolidge Dam is unclear. Matter (1991) believed all five species could live and all but grass carp reproduce in San Carlos Reservoir and from there could move further upstream on the Gila River. No bald eagle nests are known from the Gila River above San Carlos Reservoir. Effects to the bald eagle from introduction of non-native fishes into San Carlos Reservoir will be confined to the Coolidge nest. The degree of effects on the hunting territory will depend on the extent of change in fish species composition.

Introductions and survival of exotic or non-native fish species over the life of the project and beyond will alter fish species compositions in the area of bald eagle nests throughout the Gila River basin. Evidence suggests that bald eagles are not prey specific and will take whatever fish species are available to them, including a large number of non-native species (Biosystems Analysis, Inc. 1991). Unless the newly introduced fish species eliminate significant portions of the forage base presently available for eagles and are themselves not available as prey for some reason, effects to the nesting territories may not be significant.

For the bald eagle, the change in fish fauna over the life of the project may or may not have significant effects to the prey base these birds rely on. Changes to the prey base that still result in abundant, easily catchable prey, albeit of a different species, might not be significant to the maintenance of a nesting territory. Expansion of the newly introduced fish species into a wider range in the Gila River will affect the bald eagle only so far as the individual species posed a concern due to their effects on the prey base.

6. Recovery - Potential Effects

The long-term survival of an endangered or threatened species may require implementation of recovery actions as well as basic protection. Preclusion of recovery opportunities may jeopardize survival. The purposes of Congress in setting forth the Endangered Species Act are very clear. Section 2(b) of the Act states:

> "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved..."

Conserve is defined in section 3(3) to mean:

> "...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary..."

Thus, the conservation of any threatened or endangered species under the Act clearly requires recovery of that species and protection of ecosystems which would support that recovery. Loss of significant portions of recovery habitat would then be contrary to the purposes of the Act.

A major recovery strategy for endangered and threatened southwestern fishes is their reestablishment within historic range. Since the decline of these species has resulted from the destruction and alteration of their habitat and the introduction of non-native fishes into that habitat, suitable reestablishment sites are rare. Attempts at restoring destroyed or damaged habitat and removing non-native fish have met with limited success (Meffe 1983, Carothers et al. 1989). Therefore, unoccupied streams which appear to still have suitable habitat, or which have a potential for restoration and few or no non-native fishes, are critical to the recovery of these species.

Ongoing recovery programs of native fish reestablishment illustrate the difficulties of that recovery technique, particularly in relation to the problems caused by non-native species. Success of reestablishment efforts for Gila topminnow have been limited due to the difficulty in finding waters where non-native fish are not present. Because non-native fish are widespread in the Gila River basin, Gila topminnow reestablishment has been restricted to small isolated springs and streams, or stock tanks and artificial ponds. These waters are not representative of what is known to be natural topminnow habitat. Because of the small, isolated nature of most of the reestablishment sites, they are vulnerable to drought, flooding, failure of human-constructed elements, non-native introductions, and numerous other perturbations. Stocked Gila topminnow populations are commonly lost and restocking is required (Brooks 1986, Simons 1987, Bagley et al. 1991, Brown and Abarca 1992).

The reestablishment effort for razorback sucker in the Gila River basin has also met with limited success due to the ubiquitous presence of non-native fishes (Marsh and Brooks 1989, Minckley et al. 1991). Predation from non-natives, primarily ictalurid catfishes, has resulted in little or no success in stocking of small razorbacks despite the large numbers of fish stocked. Stockings have been shifted to larger individual razorback sucker placed into tributary streams, rather than the mainstream, in an effort to reduce losses to predation. Introduction and establishment of additional predatory non-natives would likely negate those efforts.

We believe the upper San Pedro River basin (above Saint David) is among the most promising recovery habitat for native Gila River fishes, including the Gila topminnow, desert pupfish, spikedace, loach minnow, and razorback sucker. Due to extensive habitat degradation in the past, 11 of the original 13 fishes native to the upper San Pedro River have been extirpated. Several species of non-native fish are now present within the system, although fewer occur there than in other areas of the Gila River basin. Severe fish kills have occurred in the past when mine spills in the upper watershed in Sonora, Mexico dropped pH levels in the river to 3.1 (Eberhardt 1981). However, 36 miles of the upper portion of the San Pedro River corridor, including about 4 miles of the lower Babocomari River, are now protected by the Bureau of Land Management as the San Pedro Riparian National Conservation Area. That protection, plus protective diking of mine tailings in Mexico, and cessation of many earlier human activities in the area, such as the Tombstone mines, the town and ore mills at Charleston, and livestock grazing in the riparian zone, have resulted in an improving aquatic and riparian system and a high potential for native fish recovery. The proposed CAP connection will substantially increase the likelihood of additional non-native fish becoming established in the upper San Pedro River basin. The probability that the upper San Pedro River basin may become so contaminated with non-native fish species that successful reestablishment of native fishes is no longer feasible increases substantially with the CAP water transfers.

The Hassayampa River in the area of The Nature Conservancy's preserve near Wickenburg and further upstream near Wagoner is also considered to be important recovery habitat for several listed fishes.

The Gila River between the mouth of the San Francisco and the upper end of the Safford Valley has recently been designated as a Riparian National Conservation Area. This portion of the river has high potential as recovery habitat for several listed and native fishes, including spikedace, loach minnow, woundfin, razorback sucker, Colorado squawfish, and bonytail chub. Introduction of additional non-native fishes into these areas will likely reduce or eliminate the use of these areas for recovery of the native fishes.

7. Cumulative Impacts

Cumulative effects are those effects of future non-Federal (State, local government, or private) activities on endangered or threatened species or that are reasonably certain to occur during the course of the Federal activity subject to consultation. Future Federal actions are subject to the consultation requirements established in section 7 and therefore, are not considered cumulative in the proposed action.

Various State, private, and local actions will be cumulative to the effects of non-native species introductions via the CAP. The States will continue to introduce sport fish and fish for sport fish prey into waters of the Gila River basin, including species already being stocked and additional species which become desirable for sport fishing. State, private, and local entities will continue to introduce non-native fish and other organisms into waters of the Gila River basin for various purposes, such as insect and weed control. Private individuals will continue to introduce non-native fish through release of live bait fish. Both the States of New Mexico and Arizona permit live bait use in the Gila River basin. Private individuals will continue to make unauthorized stockings of fish and other organisms for a variety of reasons including stocking of sport fish and release of unwanted aquarium and aquaculture fish. Non-native species being raised in aquaculture operations will continue to escape into waters of the Gila River basin.

These State, local, and private introductions of non-native species will have a strong adverse effect on the listed species being addressed here. Cumulatively, these non-Federal impacts may result in severe losses or extirpation of populations of the listed fish. In combination with introductions through CAP, such losses and extirpations pose a severe threat to the survival of all native fishes in the Gila River basin.

REASONABLE AND PRUDENT ALTERNATIVES

Regulations that implement section 7 define reasonable and prudent alternatives (RPA's) as alternative actions, identified during formal consultation, that:

(1) can be implemented in a manner consistent with the intended purpose of the action,

(2) can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction,

(3) are economically and technologically feasible, and

(4) would, FWS believes, avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat.

Many RPA's have been considered in this consultation but were rejected for various reasons during the course of consultation (see Appendix). The following RPA has evolved during the section 7 consultation process.

This RPA contains five primary elements: 1) construction and operation of upstream barriers to fish movement from the CAP aqueduct into native fish habitats, 2) monitoring for non-native fish, 3) transfer of funding to FWS for recovery and protection of listed and candidate Gila basin fishes as mitigation for adverse project effects which cannot feasibly be alleviated below the jeopardy threshold, 4) transfer of funding to the FWS for management

against non-native fish and research to support that management, and 5) implementation of an information and education program regarding non-native aquatic fishes. Implementation of all of these elements, as delineated below, is required to result in an effective removal of jeopardy.

Implementation of the RPA will extend throughout the 100-year life of the project. Delivery of CAP water within the Gila River basin or to the Santa Rosa Canal system may begin as of the date of this biological opinion.

1.1 BR shall construct physical drop structures that act as barriers to upstream fish movement at the following locations:

Aravaipa Creek - between the Aravaipa Canyon Wilderness and the mouth (2 barriers in close proximity)
San Pedro River - between Redington and Fairbank (2 barriers in close proximity)

The barriers on Aravaipa Creek shall be completed within three and one-half years of the date of this biological opinion. The barriers on the San Pedro Rivers shall be completed within six years of the date of this biological opinion.

Using the best available information, the design of the barriers shall be mutually agreed upon by BR, FWS, and Arizona Game and Fish Department (AGFD), with appropriate input from experts on southwestern U.S. fishes, hydrology, and exotic fish problems. These barriers are anticipated to rise 4 to 10 feet above the stream bottom and may not provide 100 percent probability of blocking upstream fish movement at all flows. The barriers will function in conjunction with management, as provided for in the following items, to reduce the probability of non-native fish upstream movement to a very low level.

Barrier site locations shall be subject to review by BR, FWS, and AGFD and by the land owner(s) or land management agency(s). If site acquisition is necessary, acquisition from willing sellers shall be emphasized. Condemnation of barrier sites shall be used only after all other avenues are exhausted and after review and approval by FWS and AGFD. If the necessary acquisition or rights to appropriate barrier sites cannot be obtained in the areas specified above, then formal section 7 consultation shall be reinitiated by BR.

BR or their designee shall maintain the barriers throughout the life of the project.

1.2 BR or their designee shall maintain and operate the existing electrical barriers on the Salt River Project canals between the CAP turnout and the Salt River throughout the life of the project, unless replaced by barriers mutually agreed upon by BR, FWS, and AGFD. The effectiveness of the maintenance and operation and the effectiveness of the barriers in preventing upstream fish movement will be reviewed by BR, FWS, and AGFD at intervals not exceeding 10 years. Any changes in operating protocols shall be subject to approval by FWS and AGFD.

If changes in water deliveries, usage, or other factors alter the potential for movement of fish through and between CAP, SRP, and interconnecting canals, then formal section 7 consultation may be reinitiated and the need for continued operation of the electrical barriers may be reevaluated.

1.3 BR or their designee shall maintain and operate the existing electrical barrier on the Florence-Casa Grande Canal near China Wash throughout the life of the project, unless replaced by one of the following:

a. A drop structure at the juncture of the Florence-Casa Grande Canal and the Gila River that would form a barrier (with a probability of effectiveness mutually agreeable to FWS, AGFD, and BR) to upstream fish movement from the canal into the river; or

b. A pump system for transferring Gila River water into the Florence-Casa Grande Canal which would preclude upstream movement of fish from the canal into the river.

c. Or other measures agreed upon by BR, FWS, and AGFD.

The effectiveness of the maintenance and operation and the effectiveness of the barriers in preventing upstream fish movement will be reviewed by BR, FWS, and AGFD at intervals not to exceed 10 years. Any changes in operating protocols shall be subject to approval by FWS and AGFD.

If changes in water deliveries, usage, or other factors alter the potential for movement of fish through and between CAP, Florence-Casa Grande, and interconnecting canals, then formal section 7 consultation may be reinitiated and the need for continued operation of the electrical barriers may be reevaluated.

1.4 The existing electrical barrier on the Pima Lateral Canal may be discontinued at the discretion of BR.

2. BR shall, in cooperation with AGFD and FWS, develop and implement a baseline study and long-term monitoring of the presence and distribution of non-native fish in the following areas:

CAP aqueduct
SRP canals
Florence-Casa Grande Canal
Other water delivery canals, as appropriate
Salt River between Stewart Mountain Dam and Granite Reef Dam and the electrical barriers
Gila River below Coolidge Dam
San Pedro River downstream of the U.S./Mexico border

The purpose of this effort shall be to establish baseline data on the presence and distribution of non-native fishes in the target reaches and to detect changes in the species composition or distribution.

Data collection protocols shall be cooperatively formulated by BR, FWS, and AGFD, with the final protocol requiring consensus by all three agencies. This monitoring shall begin no later than 6 months after the date of this biological opinion, and shall continue throughout the life of the project. BR shall submit reports on this sampling to FWS and AGFD on an annual basis throughout the life of the project. Comprehensive reports compiling all previous data collected under this sampling shall be prepared by BR and submitted to FWS and AGFD at the end of every 5 years following initiation of the monitoring. If a non-native fish species is found in an area where they have not previously been found, the FWS and AGFD shall be informed of the finding by telephone within 5 days of the collection.

3. BR shall deposit into an escrow-type account in the name of the FWS the sum of $250,000 annually for 25 years from the date of the first funding transfer. The first funding transfer shall occur no later than three months after the date of this biological opinion and the amount shall be prorated to

reflect the percent of the current fiscal year remaining. In all future fiscal years, funding transfer shall occur within the first two months of the fiscal year. These funds shall be used by FWS for conservation actions (recovery and protection) for the spikedace, loach minnow, Gila topminnow, razorback sucker, or other Gila River basin listed or candidate fish species. These monies shall not be subject to FWS or BR overhead charges.

Expenditure of these funds shall be jointly agreed upon by the FWS and BR in consultation with AGFD and New Mexico Department of Game and Fish (NMGF). FWS shall submit an annual report to BR detailing the expenditure of these funds and how the expenditures contribute to the removal of jeopardy from the proposed delivery of CAP water in the Gila River basin. A briefing of fund expenditures, accomplishments, and upcoming work items shall be presented by FWS at the annual joint meeting of the regional offices of BR and FWS.

4. BR shall deposit into an escrow-type account in the name of the FWS the amount of $250,000 annually for 25 years from the date of the first funding transfer. The first funding transfer shall occur no later than three months after the date of this biological opinion and the amount shall be prorated to reflect the percent of the current fiscal year remaining. In all future fiscal years, funding transfer shall occur within the first two months of the fiscal year. These funds shall be used by FWS for research on, and control of, non-native aquatic species. Research may include, but is not limited to, the status, biology, ecology, habitat, and life history of spikedace, loach minnow, Gila topminnow, razorback sucker, and other Gila River basin listed or candidate fish species; status, biology, ecology, habitat, and life history of invading or already present non-native aquatic species; toxicology of various fish toxicants to native or non-native aquatic species; and community ecology of Gila River basin fish communities with focus on interactions of native and non-native species. This fund shall not be subject to FWS or BR overhead charges.

Expenditure of these funds shall be jointly agreed upon by FWS and BR in consultation with AGFD, and NMGF. FWS shall submit an annual report to BR detailing the expenditure of these funds and how the expenditures contribute to the removal of jeopardy from the proposed delivery of CAP water in the Gila River basin. A briefing of fund expenditures, accomplishments, and upcoming work items shall be presented by FWS at the annual joint meeting of the regional offices of BR and FWS.

5. BR shall develop and implement an information and education program directed to conservation of native fish and their habitats. Emphasis shall be placed on problems caused by bait-bucket transfer, dumping of pet aquarium fish, and other forms of transport by private individuals. This program shall be implemented no later than 2 years after finalization of this Biological Opinion, and shall continue for a minimum of 5 years. Annual reports of this program shall be submitted to FWS.

Because this biological opinion has found jeopardy to the continued existence of four listed species, BR is required to notify the FWS of its final decision on the implementation of the reasonable and prudent alternative.

INCIDENTAL TAKE

Section 9 of the Act, as amended, prohibits any 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 and 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. 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 incidental take statement. **The measures described below are nondiscretionary, and must be undertaken by the agency or made a binding condition of any grant or permit issued to the applicant, as appropriate.**

The FWS anticipates that the proposed transfer of CAP water into the Gila River Basin via irrigation systems under the terms of the reasonable and prudent alternative in this opinion will result in incidental take of spikedace, loach minnow, Gila topminnow, razorback sucker, and Colorado squawfish through habitat modification causing impairment of breeding, feeding, and sheltering.

The anticipated amount of taking due to implementation of this proposed action cannot be quantified. Several species involved are short-lived, have high rates of reproduction, and experience great population fluctuations, thus making population estimates difficult to obtain and interpret. The non-native species which may invade cannot be identified and the timing of the invasions are unknown. Implementation of the RPA is expected to minimize take of the listed fish. Therefore, the level of incidental take anticipated as a result of the proposed action will be assumed to have been exceeded if the proposed action, as modified by the reasonable and prudent alternative, is altered or not carried out as set forth in this biological opinion. If this should occur, the BR must reinitiate consultation with the FWS immediately to avoid violation of section 9. If it is determined that the impact of the additional taking will cause an irreversible and adverse impact on the species, operations must be stopped in the interim period between the initiation and completion of the new consultation.

It is unlikely that any incidental take of desert pupfish or bald eagle will occur as a result of implementation of the proposed action. Accordingly, no incidental take is authorized. Should any take occur, BR must reinitiate formal consultation with the FWS and provide a description of the circumstances surrounding the take.

Reasonable and Prudent Measures

The FWS believes that the RPA given in this biological opinion includes all measures necessary and appropriate to minimize the incidental taking authorized by this biological opinion.

Terms and Conditions for Implementation

In order to be exempt from the prohibitions of section 9 of the Act, the BR is responsible for compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. Implementation of the RPA in the biological opinion will constitute the terms and conditions for this action.

The incidental take statement provided in this opinion satisfies the requirements of the Endangered Species Act, as amended. This statement does not constitute an authorization for take of listed migratory birds under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act or any other Federal statute.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the 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 FWS suggestions regarding **discretionary agency activities** to minimize or avoid adverse effects of a proposed action on listed species or regarding the development of information. The 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.

1. Construct physical drop structure barriers to upstream fish movement at the following locations:

Redfield Canyon,
Babocomari River - above Huachuca City,
Hassayampa River - between CAP aqueduct and The Nature Conservancy Preserve, and
Agua Fria River - above Lake Pleasant.

Appropriate barrier design for each site should be agreed upon by BR, FWS, and AGFD using the best available information on fish movement capabilities. Site location should be reviewed by those three agencies and by the land owner or land management agency.

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, siphon, sumps, and other open water storage and conveyance features of CAP and of 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 other open water features which cannot be dried annually, management plans to control non-native fish should be encouraged and assisted. Acceptable alternatives to drying may include use of fish toxicants, structural modification to allow dryup, structural modification to avoid flood inundation, and/or physical barriers to fish movement out of areas which cannot be dried into other portions of the system. The management plans should be mutually acceptable to BR, FWS, and AGFD.

3. Organize and facilitate a multi-agency effort to address conflicts between sport fishing (including use of live bait) and native fish conservation in Arizona and possibly New Mexico. The primary goal of this effort would be to find solutions which would provide protection to native fishes and still provide adequate sport fishing opportunities.

4. Oppose all introductions of any non-native aquatic species not already established in the Colorado River basin, into waters of the lower Colorado River basin over which BR has partial or total control. Support efforts to prevent purposeful introduction of additional non-native species into the waters of the lower Colorado River basin.

In order for the FWS to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

SUMMARY

This concludes formal consultation on the transportation and delivery of CAP water to the Gila River basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers and associated tributaries) in Arizona and New Mexico. As required by 50 CFR 402.16, reinitiation of formal consultation is required if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may impact listed species or critical habitats 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 that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by this action.

LITERATURE CITED

Bagley, B.A, D.A. Hendrickson, F.J. Abarca, and S.D. Hart. 1991. Status of the Sonoran topminnow (Poeciliopsis occidentalis) and desert pupfish (Cyprinodon macularius) in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 64 pp.

Baltz, D.M. and P.B. Moyle. 1993. Invasion resistance to introduced species by a native assemblage of California stream fishes. Ecological Applications 3(2):246-255.

Barber, W.E., D.C. Williams, and W.L. Minckley. 1970. Biology of the Gila spikedace, Meda fulgida, in Arizona. Copeia 1970(1):9-18.

Bestgen, K.R. 1990. Status review of the razorback sucker, Xyrauchen texanus. Contribution 44, Colorado State University Larval Fish Laboratory, Ft. Collins, Colorado. 92 pp.

Bestgen, K.R., S.P. Platania, J.E. Brooks, D.L. Brooks. 1989. Dispersal and life history traits of Notropis girardi (Cypriniformes: Cyprinidae), introduced into the Pecos River, New Mexico. American Midland Naturalist 122:228-235.

Bestgen, K.R., and D.L. Propst. 1986. Red shiner vs. native fishes: replacement or displacement? Proceedings of the Eighteenth Annual Symposium of the Desert Fishes Council. November 20-22, 1986.

Bestgen, K.R., and D.L. Propst. 1989. Distribution, status, and notes on the ecology of Gila robusta (Cyprinidae) in the Gila River drainage, New Mexico. The Southwestern Naturalist 34(3):402-412.

Biosystems Analysis, Inc. 1990. Ecology of bald eagles in Arizona, 1991 draft report. Report to the U.S. Dept. of Interior, Bureau of Reclamation. Boulder City, Nevada.

Black, G.F. 1980. Status of the desert pupfish, Cyprinodon macularius (Baird and Girard), in California. California Dept. of Fish and Game. Sacramento, California. 42 pp.

Brooks, J.E. 1986. Status of natural and introduced Sonoran topminnow (Poeciliopsis o. occidentalis) populations in Arizona through 1985. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 34 pp.

Brown, D.J. and T.G. Coon. 1991. Grass carp larvae in the lower Missouri River and its tributaries. North American Journal of Fisheries Management 11:62-66.

Brown, M. and F.J. Abarca. 1992. An update status report of the Sonoran topminnow (Poeciliopsis occidentalis) and desert pupfish (Cyprinodon macularius) in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 39 pp.

Carothers, S.W., G.S. Mills, and R.R. Johnson. 1989. The creation and restoration of riparian habitat in the southwestern arid and semi-arid regions. Pp. 359-371 In: Wetland creation and restoration: the status of the science. Vol. 1. U.S. Environmental Protection Agency, Corvallis, Oregon.

Courtenay, W.R., Jr., and J.E. Deacon. 1983. Fish introductions in the American southwest: a case history of Rogers Spring, Nevada. The Southwestern Naturalist 28(2):221-224.

Courtenay, W.R., Jr., J.E. Deacon, D.W. Sada, R.C. Allan, and G.L. Vinyard. 1985. Comparative status of fishes along the course of the pluvial White River, Nevada. The Southwestern Naturalist 30(4):503-524

Courtenay, W.R., Jr., D.A. Hensley, J.N. Taylor, and J.A. McCann. 1984. Distribution of exotic fishes in the continental United States. Pp. 41-77 In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

Courtenay, W.R., Jr., and G.K. Meffe. 1989. Small fishes in strange places: a review of introduced Poeciliids. Pp. 319-331 In: Ecology and evolution of livebearing fishes (Poeciliidae). G.K. Meffe and F.F. Snelson, Jr., eds. Prentice Hall. Englewood Cliffs, New Jersey.

Courtenay, W.R., Jr., and J.R. Stauffer, Jr. 1984. Distribution, biology, and management of exotic fishes. Johns Hopkins Univ. Press. Baltimore and London. 430 pp.

Deacon, J.E., C. Hubbs, and B.J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of southern Nevada. Copeia 1964(2):384-388.

Drenner, R.W., S.B. Taylor, X. Lazzaro, and D. Kettle. 1984. Particle-grazing and plankton community impact of an omnivorous cichlid. Transactions of the American Fisheries Society 113:397-402.

Eberhardt, S. 1981. San Pedro River basin water quality status report for period 1973-1979. Report of Bureau of Water Quality Control, Arizona Dept. of Health Services, Phoenix.

Echelle, A.A., and P.J. Connor. 1989. Rapid geographically extensive genetic introgression after secondary contact between two pupfish (Cyprinodon, Cyprinodontidae). Evolution 43:717-727.

Evans, D.O. and D.H. Loftus. 1987. Colonization of inland lakes in the Great Lakes region by rainbow smelt, Osmerus mordax: their freshwater niche and effects on indigenous fishes. Canadian Journal of Fisheries and Aquatic Sciences 44(Supp. 2):249-266.

Grabowski, S.J., S.D. Hiebert, and D.M. Lieberman. 1984. Potential for introduction of three species of non-native fishes into Central Arizona via the Central Arizona Project- A literature review and analysis. U.S. Bureau of Reclamation, Denver, Colorado. 225 pp.

Haynes, C.M., R.T. Muth, and L.C. Wycoff. 1982. Range extension for the redside shiner, Richardsonius balteatus (Richardson), in the upper Colorado River drainage. The Southwestern Naturalist 27(2):223.

Heckmann, R.A., J.E. Deacon, and P.D. Greger. 1986. Parasites of the woundfin minnow, Plagopterus argentissimus, and other endemic fishes from the Virgin River, Utah. Great Basin Naturalist 46(4):662-675.

Hendrickson, D.A. and A. Varela-Romero. 1989. Conservation status of desert pupfish, Cyprinodon macularius, in Mexico and Arizona. Copeia 1989(2):478-483.

Horne, F.R., T.L. Arsuffi, and R.W. Neck. 1992. Recent introduction and potential botanical impact of the giant rams-horn snail, Marisa cornuarietis (Pilidae), in the Comal Springs ecosystem of central Texas. The Southwestern Naturalist 37(2):194-214.

Howells, R.G., R.W. Luebke, B.T. Hysmith, and J.H. Moczygemba. 1991. Field collections of rudd, Scardinius erythrophthalmus (Cyprinidae), in Texas. The Southwestern Naturalist 36(2):244-254.

Hubbs, C.L., and R.R. Miller. 1941. Studies of the fishes of the order Cyprinodontes. IVII -- Genera and species of the Colorado River System. Occasional Papers of the Museum of Zoology, University of Michigan 433:1-9.

Hughes, R.M. 1981. The plains killifish, Fundulus zebrinus (Cyprinodontidae), in the Colorado River basin of western North America. The Southwestern Naturalist 26(3):321-325.

Lachner, E.A., C.R. Robins, and W.R. Courtenay, Jr. 1970. Exotic fishes and other aquatic organisms introduced into North America. Smithsonian Contributions to Zoology No. 59. 29 pp.

Marsh, P.C., F.J. Abarca, M.E. Douglas, and W.L. Minckley. 1989. Spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis) relative to introduced red shiner (Cyprinella lutrensis). Report to Arizona Game and Fish Department, Phoenix. 116 pp.

Marsh, P.C., and J.E. Brooks. 1989. Predation by ictalurid catfishes as a deterrent to re-establishment of hatchery-reared razorback suckers. The Southwestern Naturalist 34(2):188-195.

Marsh, P.C. and W.L. Minckley. 1982. Fishes of the Phoenix metropolitan area in central Arizona. North American Journal of Fisheries Management. 4:395-402.

Matsui, M.L. 1981. The effects of introduced teleost species on the social behavior of Cyprinodon macularius californiensis. MS thesis. Occidental College, Los Angeles, California. 61 pp.

Matter, W.J. 1991. Potential for transfer of non-native fish in Central Arizona Project canal waters to the Gila River system. Bureau of Reclamation, Phoenix, Arizona. 83 pp.

Meador, M.R. 1992. Inter-basin water transfer: ecological concerns. Fisheries 17(2):17-22.

Meffe, G.K. 1983. Attempted chemical renovation of an Arizona springbrook for management of the endangered Sonoran topminnow. North American Journal of Fisheries Management 3:315-321.

Meffe, G.K. 1985. Predation and species replacement in American southwestern fishes: a case study. Southwestern Naturalist 30(2):173-187.

Meffe, G.K., D.A. Hendrickson, W.L. Minckley, and J.N. Rinne. 1983. Factors resulting in decline of the endangered Sonoran topminnow Poeciliopsis occidentalis (Atheriniformes:Poeciliidae) in the United States. Biological Conservation 25(1983):135-159.

Miller, R.R. 1961. Man and the changing fish fauna of the American southwest. Papers of the Michigan Academy of Science, Arts,and Letters 46:365-404.

Miller, R.R., and L.A. Fuiman. 1987. Description and conservation status of Cyprinodon macularius eremus, a new subspecies of pupfish from Organ Pipe Cactus National Monument, Arizona. Copeia 1987(3):593-609.

Miller, R.R., J.D. Williams, and J.E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14:22-38.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department. Phoenix, Arizona. 293 pp.

Minckley, W.L. 1983. Status of the razorback sucker, Xyrauchen texanus (Abbott) in the lower Colorado River basin. Southwestern Naturalist 28(2):165-187

Minckley, W.L. 1985. Native fishes and natural aquatic habitats in U.S. Fish and Wildlife Service Region II west of the continental divide. Report to the U.S. Fish and Wildlife Service, Albuquerque, New Mexico. Dept. of Zoology, Arizona State Univ., Tempe, Arizona. 158 pp.

Minckley, W.L. and L.H. Carufel. 1967. The little Colorado River spinedace, Lepidomeda vittata, in Arizona. Southwestern Naturalist 13:291-302.

Minckley, W.L., and J.E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species". Science 159:1424-1432.

Minckley, W.L., and M.E. Douglas. 1991. Discovery and extinction of western fishes: a blink of the eye in geologic time. Pp. 7-17 In: Battle against extinction: Native fish management in the American west. W.L. Minckley and J.E. Deacon, eds. Univ. of Arizona Press, Tucson.

Minckley, W.L., P.C. Marsh, J.E. Brooks, J.E. Johnson, and B.L. Jensen. 1991. Management toward recovery of razorback sucker (Xyrauchen texanus). Pp. 303-357 In: Battle against extinction: Native fish management in the American west. W.L. Minckley and J.E. Deacon, eds. Univ. of Arizona Press, Tucson.

Moyle, P.B. 1976. Inland fishes of California. Univ. of California Press. Berkeley, California. 405 pp.

Mueller, G. 1989. Fisheries investigations in the Central Arizona Project canal system. Final Report 1986-1989. U.S. Bureau of Reclamation, Boulder City, Nevada. 114 pp.

Pister, E.P. 1979. Report of the Death Valley System Committee of the Desert Fishes Council. Proceedings of the Eleventh Annual Symposium, Desert Fishes Council. Nov. 15-17, 1979.

Platania, S.P. 1990. Reports and verified occurrence of logperches (Percina caprodes and Percina macrolepida) in Colorado. The Southwestern Naturalist 34(1): 87-88.

Propst, D.L. and K.R. Bestgen. 1991. Habitat and biology of the loach minnow, Tiaroga cobitis, in New Mexico. Copeia 1991(1):29-38.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (Meda fulgida) in New Mexico. U.S. Fish and Wildlife Service Endangered Species Report No. 15. 93 pp.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1988. Distribution, status, biology, and conservation of the loach minnow, Tiaroga cobitis, Girard, in New Mexico. U.S. Fish and Wildlife, Albuquerque, New Mexico. Endangered Species Report Number 17. 75 pp.

Propst, D.L., J.A. Stefferud, and P.R. Turner. 1992. Status and conservation of Gila trout Oncorhynchus gilae Miller. The Southwestern Naturalist. 37(2):117-125.

Rinne, J.N. 1991. Habitat use by spikedace, Meda fulgida (Pisces:Cyprinidae) in southwestern streams with reference to probable habitat competition by red shiner, Notropis lutrensis (Pisces:Cyprinidae). The Southwestern Naturalist 36(1):7-13.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 12. 174 pp.

Salt River Project. 1994. Letter to Arizona Game and Fish Department re electric barrier outage and white amur movement. February 11, 1994. Phoenix, Arizona. 2 pp.

Schoenherr, A.A. 1981. The role of competition in the replacement of native fishes by introduced species. Pp. 173-203 In: Fishes in North American deserts. R.J. Naiman and D.L. Soltz, eds. Wiley-Interscience Pub., New York, New York.

Schoenherr, A.A. 1988. A review of the life history and status of the desert pupfish, Cyprinodon macularius. Bulletin of the Southern California Academy of Science 87(3):104-134.

Shaflund, P.L., and J.M. Pestrak. 1983. Suppression of largemouth bass production by blue tilapia in ponds. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 37:441-446.

Simons, L.H. 1987. Status of the Gila topminnow (Poeciliopsis occidentalis occidentalis) in the United States. Special Report on Project E-1. Arizona Game and Fish Department. Phoenix. 36 pp.

Stauffer, J.R., Jr. 1984. Colonization theory relative to introduced populations. Pp. 8-21. In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

Stefferud, S.E., and J.A. Stefferud. 1989. A brief sampling of fish and aquatic habitat in the upper San Pedro River, March 24-26, 1989. Report to Bureau of Land Management, Huachuca City, Arizona. 11 pp.

Taylor, J.N., W.R. Courtenay, Jr., and J.A. McCann. 1984. Known impacts of exotic fishes in the continental United States. Pp. 322-373. In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

University of Arizona. 1993. Game-plan at Maricopa Agricultural Center. Arid Lands Fish Production, Jan./Feb. 1993 II(1):1.

U.S. Department of the Interior, Bureau of Reclamation. 1987. Central Arizona Project Canal System Fishery Investigations Progress Report. Bureau of Reclamation, Boulder City, Nevada. 60 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1988. Central Arizona Project Canal System Fishery Investigations Progress Report. Bureau of Reclamation, Boulder City, Nevada. 59 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1990a. Garrison Diversion Unit joint technical committee report to the United States-Canada consultative group (including the Biology Task Force report). November 1990. Bureau of Reclamation, Billings, Montana. 57 + 73 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1990b. Memorandum to San Carlos Irrigation Project re electric barrier outage. July 9, 1990. Bureau of Reclamation, Phoenix, AZ. 2 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1992. Summary of fish and water quality sampling along the San Pedro River from Dudleyville to Hughes Ranch near Cascabel, Arizona, October 24 and 25, 1991, and the Gila River from Coolidge Dam to Ashurst/Hayden Diversion Dam, October 28-31, 1991. February 26, 1992. Bureau of Reclamation, Phoenix, Arizona. 11 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1982. Southwestern bald eagle recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 65 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1983. Arizona trout recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 37 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1984. Gila and Yaqui topminnow recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico 56 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1991a. Endangered and threatened wildlife; the razorback sucker (Xyrauchen texanus) determined to be an endangered species. Federal Register 56(205):54957-54967.

U.S. Department of the Interior, Fish and Wildlife Service. 1991b. Colorado squawfish revised recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 56 pp.

Vrijenhoek, R.C., M.E. Douglas, and G.K. Meffe. 1985. Conservation genetics of endangered fish populations in Arizona. Science 229:400-402.

Wells, S.M., R.M. Pyle, and N.M. Collins. 1983. The IUCN invertebrate red data book. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland. 301 pp.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye. 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20(1):1-62.

Williams, J.E., and D.W. Sada. 1985. Status of two endangered fishes, Cyprinodon nevadensis mionectes and Rhinichthys osculus nevadensis, from two springs in Ash Meadows, Nevada. The Southwestern Naturalist 30(4):475-484.

APPENDIX

REJECTED REASONABLE AND PRUDENT ALTERNATIVES BIOLOGICAL OPINION ON THE TRANSPORTATION AND DELIVERY OF CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN

During the extensive discussions in the development of the final reasonable and prudent alternative (RPA) several quite different conceptual approaches to removal of jeopardy were considered and rejected along with a wide variety of actions to implement those approaches. The rejected RPA's listed below include conceptual approaches, specific actions, and various combinations of all or part of the actions found in the final RPA.

1. Conceptual approaches:

   a. RPA actions should focus on preventing non-native species from entering the CAP aqueduct. The basic line of defense should be at the intake of CAP at Lake Havasu with secondary defenses to prevent those species that get into the CAP aqueduct from getting out into the Gila basin, and tertiary defenses to prevent those species which get into the Gila basin from entering important listed species habitats. This approach was rejected because successful exclusion of non-native species from the CAP aqueduct is unlikely and not considered vital to protection of listed species.

   b. RPA actions should focus on preventing non-native species from entering the Gila basin from the CAP aqueduct. The basic line of defense should be to prevent non-native species from moving out of the CAP aqueduct into the Gila basin. A secondary line of defense should be to prevent those non-native species which get into the Gila basin from entering important listed species habitats. This approach was rejected because of technological and economic considerations and was replaced by a concept in which RPA actions focus on preventing non-native species from entering important native fish habitats. No secondary line of defense exists with this approach.

2. Use of screens, bar racks, and/or pumps on turnouts from CAP; rejected due to technical infeasibility.

3. Treatment of CAP water with ozone or other chemicals to kill fish, larvae, and eggs; rejected due to economic infeasibility of ozonation, and unacceptable environmental consequences of other chemicals.

4. Closure of the Gila River at the base of Coolidge Dam to fishing and public access; rejected because it is outside the authority of BR.

5. Creation of a fund for contingency management as a proportion of water receipts, with BR implementation of contingency management; rejected in favor of direct BR funding to FWS using existing species conservation infrastructure.

6. Additional electrical barriers; rejected due to lack of data on electrical barrier effectiveness.

7. Evaluation of measures to make Ashurst-Hayden Dam a fish barrier and implementation of only those measures that are cost-effective; rejected due to lack of relationship between removal of jeopardy and cost-effectiveness.

8. Modification of Ashurst-Hayden Dam to form a compete fish barrier; rejected as part of concept 1(b).

9. Assist in treatment of Aravaipa Creek with rotenone; rejected due to need for extensive evaluation of environmental consequences including take and possible jeopardy of the listed fish.

10. Request all agencies to stop stocking non-native fish in the Gila River drainage; rejected as unenforceable and therefore ineffective in relieving jeopardy. Incorporated into a more comprehensive Conservation Recommendation.

11. Request the Game and Fish Departments of Arizona and New Mexico to stop live bait use in the Gila River basin; rejected due to high probability of ineffectiveness. Incorporated into a more comprehensive Conservation Recommendation.

12. Continuation of funding for the bald eagle nest watch program; rejected because the finding for bald eagle is non-jeopardy and this element is not effective in relieving jeopardy for listed fish.

13. Various locations and combinations of physical and electrical barriers, particularly on the Gila River; rejected as parts of concepts 1(a) and (b).

14. Construction of sets of barriers on the Gila and lower San Pedro Rivers to form management zones between barriers that could be managed to control or remove non-native species; rejected as part of concept 1(b).

15. Require annual dryup or non-native fish management in all canals, ditches, siphons, sumps, and other open water sources and conveyances of CAP and entities receiving CAP water; this was part of a an approach which included preventing access of non-natives to the CAP aqueduct which was rejected as part of concept 1(a). Specific actions were moved into the Conservation Recommendations.

16. Modification of points of discharge into the Gila River downstream from canals and ditches to prevent pooled year-round water; rejected as part of concept 1(a).

17. Conduct a program of test applications of piscicide to the Gila River between Coolidge and Ashurst-Hayden Dams and possibly the San Pedro River to refine techniques for non-native fish removal and native fish reestablishment; rejected because existing techniques and expertise are adequately developed for contingency purposes and due to the need to conduct extensive analysis of the potential need for and impacts of such an effort.

18. Maintenance of the existing Pima Lateral electrical barrier; rejected as unnecessary due to other actions in RPA.

19. Study the effectiveness of the existing electrical fish barriers at preventing upstream fish movement; replaced by transfer of funding to FWS for research to support non-native fish management.

20. Prohibit fishing and public access in the CAP; rejected as part of concepts 1(a) and (b).

21. Oppose the introduction of additional non-native aquatic species into waters of the Colorado River basin; rejected as part of concepts 1(a) and (b) and placed into the Conservation Recommendations.

22. Preparation and implementation by BR of management plans for controlling or removing invading non-native fish species; replaced by transfer of funding to FWS for these actions.

23. Development of methods for assessing the probability that an invading non-native fish species came from the CAP; rejected as part of concepts 1(a) and (b).

24. Funding and oversight by BR of research on listed and non-native fishes; rejected in favor of transfer of such funding to FWS for implementation.

25. Transfer of recovery and management of Gila basin native fishes to BR under the oversight of a multi-party team; rejected because of questions regarding legality, because of potential conflicts with Arizona and New Mexico Game and Fish Departments, and because existing infrastructure for recovery and management already exist in the FWS and States.

26. Monitoring of non-native fish in the lower Verde River and Aravaipa Creek; rejected as not required for removal of jeopardy.

27. Geohydrologic study of the Bylas Springs complex; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

28. Study of the fluvial geomorphology of Aravaipa Creek in relation to human uses and watershed stability; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

29. Installation and operation of 15 stream flow gages and 4 water quality monitoring stations in the Gila River basin; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

30. Devising solutions to the groundwater mining and depletion in the upper San Pedro River basin to protect surface flow in the river; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

31. Devising methods for modernizing irrigation diversions in the Cottonwood and Camp Verde areas of the middle Verde River basin to increase instream flow; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.