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Memorandum

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

From: Field Supervisor

Subject: Revised Biological Opinion on 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 and its Potential to Introduce and Spread Nonnative Aquatic Species

This revised biological opinion is in response to a January 3, 2001 request by the Bureau of Reclamation for reinitiation of formal consultation, pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.), on transportation and delivery of water through the Central Arizona Project (CAP) in the Gila River basin and its potential to introduce and spread nonnative aquatic species. The Santa Cruz River subbasin of the Gila basin is the subject of a separate consultation and is not addressed here. This biological opinion supercedes the April 15 (transmitted April 20), 1994 biological opinion on the same subject. Reinitiated consultation began on January 3, 2001, the date Reclamation's request was received by the Fish and Wildlife Service.

Reinitiation has been requested as a result of a court order that found the amendments to the 1994 biological opinion to be arbitrary and capricious (see consultation history section). This finding was based primarily upon the delays in implementation of the reasonable and prudent alternative, particularly barrier construction. The court concluded that take in excess of that anticipated by the 1994 opinion, had occurred to spikedace and loach minnow. This revised opinion considers the effects of all implementation delays and of such take, along with all relevant new or additional information that has become available since 1994.

This opinion addresses the possible effects of the action on the endangered Gila topminnow, razorback sucker, desert pupfish, and Colorado squawfish, and the threatened spikedace, loach minnow, and bald eagle. These species were all addressed in the 1994 opinion. In addition, due to new information, the endangered Gila trout, and threatened Apache trout are also species of concern in this opinion. The Chiricahua leopard frog, a proposed threatened species, was considered in your biological assessment, but will not be addressed in this biological opinion.

Due to the need to consider information in addition to that covered in this opinion and to litigation-related time constraints, the Chiricahua leopard frog addressed separately by Reclamation. Scientific names for these and other species referred to by common names in this document are found in Appendix 1.

This biological opinion is based on the 1994 biological opinion, which is incorporated here by reference (USFWS 1994); information used in the preparation of the 1994 biological opinion; the January 3, 2001 biological assessment (USBR 2001); the March 16 and March 30, 2001 Reclamation memoranda amending the biological assessment; April 6-13, 2001 comments on the draft biological opinion from Reclamation, Central Arizona Water Conservation District (CAWCD), Gila River Indian Community (GRIC), and the Center for Biological Diversity; telephone conversations; meetings; data in our files; and other sources of information. References cited in this biological opinion are not a complete bibliography of all literature available on the species of concern, the effects of the proposed action, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file in this office.

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CONSULTATION HISTORY

More detailed information on the topics discussed in this section, including dates of meetings, letters, and memoranda, can be found in the administrative record and is summarized in a document attached to this biological opinion entitled *Background Information on the Central Arizona Project and Nonnative Aquatic Species in the Gila River Basin* (from hereon referred to as the background document)(USFWS 2001a).

PAST CONSULTATIONS ON CAP

Since 1983, there have been numerous consultations on various aspects of CAP. Of those consultations, five addressed nonnative species issues, including the 1994 biological opinion for this consultation and an ongoing formal consultation on the issue of introduction and spread of nonnative aquatic species, via CAP, in the Santa Cruz River subbasin. A draft biological opinion for the latter was issued on June 11, 1999 finding jeopardy to Gila topminnow.

APPLICANTS

There were no requests for applicant status during the 1991-94 formal consultation on this project, which ended in the April 15, 1994 biological opinion. In December 2000, Reclamation granted applicant status in this consultation to CAWCD and GRIC. Comments on the April 3, 2001 draft biological opinion were received, through Reclamation, from GRIC on April 9, and from CAWCD on April 13, 2001.

APRIL 15, 1994 BIOLOGICAL OPINION

Informal Consultation for the 1994 Biological Opinion

Informal consultation began in 1986 on possible impacts of construction of the Pima Lateral Feeder Canal connection between the CAP aqueduct and the Florence-Casa Grande Canal system. In May 1991, analysis for the Santa Cruz River subbasin was separated from the analysis for the rest of the Gila River basin because operational details for the Santa Cruz portion of the CAP were not yet complete and information was lacking.

Formal Consultation for the 1994 Biological Opinion

Formal consultation for the 1994 biological opinion was initiated on February 12, 1991. A draft biological opinion was sent to Reclamation on May 30, 1991. After extensive negotiations over the reasonable and prudent alternative, the final biological opinion (dated April 15, 1994) was sent to Reclamation on April 20, 1994.

The 1994 biological opinion analyzed effects of the transportation and delivery of CAP water to the Gila River basin (excluding the Santa Cruz River subbasin) and its potential to introduce and spread nonnative aquatic species. The opinion considered effects to seven listed species and found that the proposed action was likely to jeopardize the continued existence of spikedace, loach minnow, Gila topminnow, and razorback sucker; was likely to adversely modify the critical habitat of spikedace, loach minnow, and razorback sucker; but would not jeopardize the continued existence of desert pupfish, Colorado squawfish, or bald eagle. The reasonable and prudent alternative of that biological opinion called for a 5-part program to remove the jeopardy and adverse modification; including 1) physical barriers, 2) monitoring, 3) recovery in-lieu of threat removal, 4) management against nonnative species, and 5) information and education. Implementation of the 1994 biological opinion is ongoing.

On March 7, 1997, the Southwest Center for Biological Diversity filed suit, alleging that the biological opinion was inadequate because the reasonable and prudent alternative did not sufficiently remove jeopardy and adverse modification; Southwest Center for Biological Diversity v. Babbitt, Civ. No. 97-474-PHX-SMM (D.Ariz). On July 14, 1997, CAWCD filed suit, alleging that the biological opinion was flawed because no jeopardy or adverse modification was created by CAP activities; Central Arizona Water Conservation Dist. v. Babbitt, Civ. No. 97-1470-PHX-SMM (D. Ariz.). These suits were consolidated on August 24, 1997.

On September 30, 1999, the district court upheld the Service’s jeopardy conclusion in the 1994 biological opinion. In a September 22, 2000 order, the court upheld the reasonable and prudent alternative in the 1994 jeopardy biological opinion, but also held that subsequent amendments to the reasonable and prudent alternative were arbitrary and capricious.

Accordingly, Reclamation and the Service reentered formal consultation. This biological opinion is the direct result of that consultation. Reclamation has continued to implement the terms of the reasonable and prudent alternative during reconsultation.

2001 REINITIATED CONSULTATION

Informal Consultation

Informal consultation for this reinitiation began in October 2000. On November 3, 2000, Reclamation requested formal reinitiation of section 7 consultation, but provided no biological assessment or other information on changes to the project, water use, environmental baseline, or any other information that might change the analysis of effects of the project on listed species. On November 21, 2000, the Service requested the pertinent information be furnished prior to initiation of formal consultation. The Service also committed to complete formal consultation by April 17, 2001, if the necessary information was furnished and formal consultation successfully initiated by January 3, 2001, and presuming rapid review by Reclamation and the applicants.

Formal Consultation

A biological assessment was delivered to the Service and formal consultation was initiated on January 3, 2001. In that biological assessment, Reclamation included the 1994 reasonable and prudent alternative as a part of the proposed action. The reasonable and prudent alternative and other mitigative commitments made in the proposed action will be referred to in this biological opinion as *conservation measures*. The purpose of these conservation measures is to avoid the likelihood that the transportation and delivery of CAP water in the Gila River basin will jeopardize the continued existence of any listed species or destroy or adversely modify any designated critical habitats.

Reclamation and the Service conducted a series of meetings and telephone calls from January through March 2001, to work out details of the conservation measures and other pertinent portions of the biological opinion. A meeting with the applicants was also held on March 2, 2001. Addenda to the biological assessment were submitted on March 16 and 30, 2001 with additions and refinements to the conservation measures. A draft biological opinion was delivered to Reclamation, the applicants, and the Center for Biological Diversity on April 3, 2001. Comments were received from all of those on April 6-13, 2001.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The CAP was constructed to provide a long-term, non-groundwater, water source for municipal, industrial, and agricultural (Indian and non-Indian) users in central and southern Arizona. The water provided through the CAP aqueduct is Arizona's remaining entitlement to the flow of the Colorado River. The water is taken from the Colorado River at Lake Havasu and is conveyed 336 miles (540 kilometers) across the state in a series of large, open, concrete-lined aqueducts (Figure 1). Construction began in 1973 and the system was declared substantially completed in 1993 (CAWCD 1995).

Although the CAP aqueduct extends as far south as Tucson, this biological opinion considers only that portion of the CAP system that has potential to introduce or spread nonnative aquatic species into all parts of the Gila River basin, other than the Santa Cruz subbasin. That includes the aqueduct and connected, interrelated, and interdependent features along the 249 mile (400 kilometer) segment from the Lake Havasu Pumping Plant on the Colorado River to the Casa Grande Extension turnout northeast of Picacho Reservoir. A separate, ongoing consultation for the Santa Cruz River subbasin considers that portion of the CAP system that has potential to introduce or spread nonnative aquatic species into the Santa Cruz subbasin. That includes the aqueduct and connected, interrelated, and interdependent features along the 93 mile (149.5 kilometer) segment from the Pima Lateral Turnout near Florence to the present aqueduct terminus near Pima Mine Road and the Interstate 19 interchange, about 15 miles (25 kilometers) south of Tucson. The Pima Lateral, Kleck Road, and Casa Grande Extension turnouts are considered in both consultations, due to potential for movement of nonnative species through those turnouts and into either the Gila or Santa Cruz Rivers.

The project scope considered in this reconsultation is the same as for the 1991-94 consultation, although details are now available about some project elements covered programmatically in the earlier opinion. A September 30, 1999 court order on this consultation (Southwest Center for Biological Diversity v. Babbitt, CIV. No. 97-474-PHX-SMM [D. Ariz.]) concluded the discretionary Federal action triggering the 1991-94 consultation was the proposed construction and operation of the Pima Lateral Feeder Canal turnout that would transfer CAP water into existing irrigation canal systems near the confluence of the Gila and Santa Cruz Rivers (Figure 2). At the time, four other turnouts (North Side Canal, Florence Canal, Florence Cross-Cut, and Casa Grande Extension) were proposed that would also transfer CAP water into existing irrigation canal systems in the same area. These were specifically mentioned and considered as part of the proposed action in the 1994 biological opinion. However, once it was recognized that the Pima Lateral Feeder Canal turnout was only a small part of a much larger, systemic problem, the consultation became programmatic in nature and the 1991 formal Reclamation request asked for consultation on "possible impacts to Federally-listed endangered species for the CAP due to the transfer of nonnative fish." The consultation then considered all ongoing and future

Reclamation discretionary actions, including the five turnouts proposed at the time of the consultation, possible future turnouts, and any other project-wide operational or infrastructure features falling within the parameters of the analysis.

However, the Pima Lateral Feeder Canal turnout and other discretionary Reclamation actions for CAP are only a part of a highly complex water delivery system. The system also includes significant State and private actions, and some aspects of CAP include inextricably intertwined Federal and State or private actions and responsibilities (Table 1). The effects to listed species from the Federal portion of the overall CAP are dependent upon, and cannot be logically analyzed in isolation from, the remainder of the CAP system. Although section 7 consultation applies to Federal actions only, once a Federal action triggers consultation for CAP, then the entire CAP project falls under the purview of the consultation. The environmental baseline of the consultation considers earlier completed Federal actions, such as construction of CAP, as well as earlier State and private activities in relation to CAP. Operation and maintenance of the CAP and delivery of water is conducted by CAWCD, a political subdivision of the State. However, prior to 1993, most of the funding for that was Federal. In 1993, formal transfer of CAP to CAWCD ended Federal funding of operation and maintenance, so delivery of CAP water is not strictly a part of the proposed action under consultation, with the exception of deliveries to Tribes where the contract is held by the Federal government. However, past water deliveries are part of the environmental baseline and future operation and maintenance is a State action that is both interrelated and interdependent to the Reclamation discretionary CAP action and is also a reasonably foreseeable State action that is cumulative to the Federal action. A number of private actions using CAP water, such as some recharge projects, are also interrelated, interdependent, and cumulative to the proposed Federal action. Although different parts of the CAP fit into the section 7 analysis in different regulatory contexts, we here describe the system and its operation as a whole. This lack of segregation of description of various parts of the project according to their regulatory context is not intended to imply those distinctions do not exist, but rather to give a coherent picture of the entire system.

The Lake Havasu to Casa Grande Extension turnout portion of the aqueduct has a transport capacity ranging from 3,000 cubic feet per second (85 cubic meters per second) at the Lake Havasu Pumping Plant to just slightly less (2,800 cubic feet per second [79 cubic meters per second]) at the Salt-Gila Pumping Plant just south of the Salt River siphon. Water in excess of demand is stored behind New Waddell Dam (Lake Pleasant) on the Agua Fria River, northwest of Phoenix, and is released back into the aqueduct when demand arises. In Lake Pleasant water from CAP mingles with water from the Agua Fria drainage. There are 37 turnouts along this reach, which send water into a number of different canal, irrigation, and other delivery systems beginning near the town of Salome in the Centennial Wash subbasin. Five pumping plants are located along the reach, as well as three tunnels and eight inverted siphons (crossing surface drainages). Changes from 1994 to 2001 in system features are limited to four new turnouts, one in the Centennial Wash subbasin, two in the Agua Fria River subbasin, and one in the Gila River subbasin. Additional turnouts or other changes in project features may be constructed during the 100 year life of the CAP project.

The Lake Havasu to Casa Grande Extension turnout portion of the CAP system delivers water to approximately 88 users (Table 2) and other deliveries may be made on an intermittent or one-time basis. Many of these users will remain the same throughout the life of the project, but some change in users is expected, such as through water leasing (Ak-Chin/Anthem) or exchange (Camp Verde/Scottsdale). Deliveries are expected to approach 1.5 million acre feet per year (1.9 billion cubic meters per year) in the near future and be maintained at that level throughout the life of the project. Water deliveries are for a wide variety of uses, but fall into four general categories; non-Indian agricultural, municipal and industrial, recharge, and Indian use.

Non-Indian Agricultural Use

Water from CAP for agricultural use is delivered at various points throughout the system. Substantial agricultural areas exist within all of the subbasins of the Gila River watershed crossed by the aqueduct. Water is conveyed from the main aqueduct generally via open canals into other canal systems that deliver water to irrigated fields. Some of these systems, such as the Florence-Casa Grande Canal and the SRP South and Arizona Canals, have direct connections with surface drainages. Others do not normally have direct connection, but may have periodic connections through irrigation returns, excess water sumping, or system cleanouts, or may have unanticipated connections during flooding or when canal components along, across, or near streams fail. Any system components that are located within the channel or floodplain of a stream are considered likely to have some connection to surface flows at some time. This may result from canals or sumps being inundated during high flood events or from siphons, dikes or canals being washed out, thus allowing mingling of CAP and surface waters.

Agricultural practices vary, over space and time, and are expected to change over the 100-year project life. Although many agricultural operations now use level-basin irrigation where excess water return systems are not necessary, over the 100-year project life there are expected to be times, areas, or circumstances in which irrigation return flows will enter surface drainages or in which excess irrigation water will be dumped into sumps within the floodplain of Gila basin surface drainages. Use of CAP agricultural water for aquaculture may result in a number of practices that may allow perennial or periodic connections between CAP waters and Gila basin surface waters.

Besides normal agricultural deliveries, since 1994 some CAP water users have received CAP water as part of the State of Arizona's in-lieu recharge program, where groundwater use is replaced with CAP water use. Such use through the Maricopa Water District Groundwater Savings Facility and the SRP Groundwater Savings Facility results in agricultural use of CAP water in areas where standard CAP allocations are not available.

Municipal and Industrial Use

Although the original purpose of CAP was to provide agricultural water, municipal and industrial use is the fastest growing portion of CAP water use and is expected to become dominant over the 100-year project life. The purpose, mechanisms, and locations of municipal and industrial use are quite variable, and are expected to change significantly over the project life. At present there are about 35 municipal and industrial users in the Lake Havasu to Casa Grande extension reach. They are mainly concentrated in the Phoenix metropolitan area.

Present use of municipal and industrial water generally falls into two categories: 1) water treated to meet drinking standards, and 2) water used untreated. Treated water has been filtered, chlorinated, ozonated, or otherwise rendered completely free of living organisms. In general, use of treated water has no likelihood of transport of nonnative species. However, if it is directly, or through discharge of wastewater, used to create wetlands or ponds, then there is potential for creation of habitat or avenues of spread for nonnative species.

The primary uses of untreated municipal and industrial water are decorative and recreation lakes, turf irrigation projects, or recharge. Recharge is addressed below. Turf irrigation is unlikely to create connections between Gila basin surface and CAP water, but may if there are irrigation return flows or sumping. Decorative and recreation lakes, often associated with housing developments or golf courses, are usually isolated from surface waters and have no outflow. However, some are connected, at least periodically with surface drainages. Some are located within stream channels, such as Rio Salado Town Lake which is located directly in the bottom of the Salt River channel and which will mingle Salt River water with CAP water. During flood events, the mingled water will become part of the general flow of the Salt River.

Recharge Use

Although some recharge projects were being contemplated at the time of the earlier consultation, there has been an increase in projects where CAP water is involved in efforts to recharge groundwater, using either untreated CAP water, effluent from other activities using CAP water, or water made available by substituting CAP water for its previous use. We do not have a complete list of all of the recharge projects. Information on three new recharge projects that have been started by CAP water users since 1994 was furnished in the biological assessment. Those three users are the Avondale Wetlands Recharge Project, the SRP Granite Reef Storage Project, and the Central Arizona Groundwater Replenishment District and all are using untreated CAP water, either alone or blended with other water. In addition, the biological assessment identifies 10 groundwater recharge projects planned for implementation in the near future that will use CAP water. At least 4 of those plan to use in-channel recharge facilities.

Recharge may be conducted in a variety of locations and designs, including within drainage channels, stream bottoms, and river floodplains; off-channel basins; constructed wetlands; or in-lieu groundwater use. Recharge is typically accomplished in shallow constructed basins or natural river channels, however details would vary greatly. Some would involve pipelines and conveyance canals and recharge basins varying from a few acres to several hundred acres in size. Some recharge basins may be maintained as permanently watered, while others are frequently dried or operated under wet/dry cycles to maintain infiltration effectiveness. In-channel projects involve impoundments within natural drainage channels or simply allowing the water to flow down natural drainage channels. Some in-channel and floodplain projects include riparian enhancement or recreation and would normally have perennial flow or pooled water. Connection between CAP water and Gila basin surface waters will occur periodically for recharge projects within stream channels or on floodplains. Off-channel basins are unlikely to have such connection so long as they are located outside of areas that would be flooded during precipitation events.

Indian Use

Several Indian communities have executed contracts for CAP water service in the Gila basin (excluding the Santa Cruz subbasin), including the Ak-Chin and Gila River Indian Communities, and the San Carlos Apache, Camp Verde Yavapai-Apache, Tonto-Apache, Fort McDowell Yavapai, and Salt River Pima-Maricopa Tribes. At present, not all of these allocations are being completely used. Existing use of this water is used primarily for agriculture and connections to Gila basin surface waters, similar to those described under non-Indian agricultural uses, may occur.

In addition, CAP water has been used in settling Indian water rights claims. How water allocated in these settlements will be used is uncertain. The Gila River Indian Community is receiving a settlement allocation of 155,400 acre feet per year (237,448,750 cubic meters per year) in addition to their original CAP allocation of 173,100 acre feet per year (213,396,000 cubic meters per year). This additional water may be used to create shifts in water usage and distribution in the Gila River basin from Ashurst-Hayden Dam upstream into New Mexico. Depending upon the outcome of that, the analysis in this biological opinion may need to be reexamined to determine if the changes in water usage and distribution would alter the conclusions.

Interrelated and Interdependent Actions and Indirect Effects

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

The relationship among interrelated and interdependent actions, cumulative effects, and indirect project effects is confusing and may overlap. See Table 3 for definitions and information on how these various parts of a section 7 analysis relate. Because of the delay in time inherent in indirect effects and the consequent intervening levels of related causation, it may become difficult to completely separate the indirect effects of the Federal action from direct or indirect effects of non-Federal actions that are interrelated and interdependent. Indirect effects of the interdependent and interrelated actions and the proposed action are included in the overall analysis of effects and will not be further discussed in this section.

The primary interrelated and interdependent action for CAP in the Gila River basin is the operation and maintenance of CAP, including water delivery, by CAWCD. Those actions, and the very existence of CAWCD, would not have occurred but for the CAP. Various uses of CAP water by State, Tribal, and private entities are also interrelated and interdependent actions that would not occur but for CAP. To the extent to which some of such uses might occur in the absence of CAP, using water from other sources, those uses may not be interrelated and interdependent, but are cumulative to the Federal action and will be addressed later in the cumulative effects section (see also Table 3).

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

The increase in human population in the Gila River basin in turn fuels a need for additional water development, particularly in areas of CAP "exchanges" where outlying communities exchange or sell their CAP allocations for rights to local water or for funds with which to develop additional surface or groundwater supplies. Three biological opinions on effects of these "exchanges" to listed species have already been issued, one for the upper Gila River in New Mexico, one for the upper Verde River, and one for the middle Verde River (see Table 1). Those opinions addressed that portion of past additional water development resulting from CAP allocations that involved Federal action and therefore the losses incurred to listed species become part of the environmental baseline of this biological opinion. However, many of the future water development actions expected due to exchange of CAP allocations, and the induced growth that may result, do not involve Federal actions, funds, or permits. In general, those actions would not occur except for the CAP allocation, therefore they may be interrelated and interdependent to the CAP and their effects must be considered as part of the analysis of the consultation. These actions may also be considered an indirect effect of the proposed Federal action. To the extent to which some of this water development might occur in the absence of CAP, using water from other sources, those uses may not be interrelated and interdependent, but are cumulative to the Federal CAP action, and will be addressed later in the cumulative effects section.

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

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

Conservation Measures

In this reconsultation, Reclamation has incorporated into their project an enhanced version of what was the reasonable and prudent alternative of the 1994 biological opinion. These conservation measures are set forth in the biological assessment and its addenda. Below, we have organized the conservation measures according to the structure of the 1994 reasonable and prudent alternative to facilitate a comparison of the effectiveness of the two.

1. Construction and operation of upstream barriers to fish movement.

1.1 Physical drop structures. The purpose of these barriers is to reduce to a very low level the probability of upstream movement of CAP introduced or mediated nonnative fish.

Aravaipa Creek: The paired concrete drop barriers currently under construction about 6 miles (10 kilometers) upstream from the confluence with the San Pedro River is expected to be completed by mid-April 2001. Reclamation or its designee will maintain these barriers over the 100-year life of the CAP project. The design and siting of this barrier was agreed to by Reclamation, the Service, and AGFD.

San Pedro River: A single concrete drop barrier will be constructed on the San Pedro River somewhere between the town of Fairbank and the confluence of the San Pedro with the Gila River. The site will be selected in agreement among Reclamation and the Service, in consultation with AGFD. The barrier will be completed by 5 years from the date of this consultation (March 2006). Barrier design is expected to be similar to the Aravaipa barriers and final design for this site will be agreed upon between Reclamation and the Service. This barrier will be maintained by Reclamation or its designee for the 100-year life of the CAP. If this barrier is prevented by factors outside Reclamation's control, an acceptable alternative barrier site will be agreed to in discussions with the Service. It is recognized here that reinitiation of formal consultation will not be necessary if a mutually agreeable site is selected and if no effects to listed species will occur in addition to those already addressed in this biological opinion.

1.2/3 Electrical barriers. The purpose of these barriers is to reduce to a very low level the probability of upstream movement of CAP introduced or mediated nonnative fish.

Reclamation will, throughout the 100-year project life of the CAP, insure the continuous operation and maintenance of the existing electrical fish barriers on the Salt River Project (SRP) Arizona and South Canals between the CAP turnout and the Salt River and on the Florence-Casa Grande Canal at China Wash. Reclamation will work with SRP and San Carlos Irrigation Project (SCIP) to ensure that existing design and operation deficiencies are corrected by making the following modifications: 1) a small drop structure or "lip" will be added across each canal along the downstream edge of the weirs upon which the electrical barriers are situated to prevent upstream movement of fishes during periods when water depths and discharges are low, 2) lightning protection will be installed on each barrier to prevent electrical outages due to lightning, 3) the electrical output of the barriers will be increased to enhance effectiveness against movements of small-bodied fishes, and 4) drawdown and rewatering procedures in the Standard Operating Procedures will be tightened to avoid barrier transgressions by fish during these events. For the Florence-Casa Grande China Wash barrier, these modifications will be completed by December 31, 2001. For the Salt River Project barriers, the Arizona Canal barrier modifications will be completed by February 28, 2002, and the South Canal barrier modifications will be completed before August 31, 2002. These lengthy waits to accomplish the modifications are due to the need for SCIP and SRP to dry up the canals during the work. Every attempt will be made to accomplish the South Canal modification earlier than the date given above.

Reports reviewing the effectiveness of the operation and maintenance of the electrical barriers will be provided to the Service, AGFD, and other interested parties at not greater than 10-year intervals. The first such report will be transmitted by June 30, 2001. The reports will be subject to review by the Service. Any changes to the Standard Operating Procedures for the electrical barriers will be subject to review and approval of the Service in consultation with AGFD.

If, in the future, the modifications described above are considered by Reclamation and the Service to be ineffective, then the barriers may be replaced by other technologies. This possible replacement is recognized here as not being subject to further section 7 consultation provided that the replacement system is mutually agreed to by Reclamation and the Service and that no additional effects to listed species will occur outside of those considered in this biological opinion. In addition, if water deliveries, usage, or other factors alter the potential for movements of fishes through or around the electrical barriers, Reclamation will hold discussions with the Service to determine if further consultation is needed. If the Service recommends reinitiation of consultation, Reclamation will do so at the earliest opportunity. If a massive failure of the electrical barriers occurs, including any outage that cannot be rectified according to established Standard Operation Procedures, then Reclamation will reinitiate consultation.

1.4(new) Physical drop structures for recovery. The purpose of these barriers is to achieve enhanced status for spikedace, loach minnow, and to a limited extent razorback sucker, through recovery to compensate for threats from CAP that cannot feasibly be removed or prevented. These barriers will either protect existing populations of spikedace and loach minnow or will provide for repatriation efforts of spikedace, loach minnow, and in some cases razorback sucker. Nonnative control and removal actions and repatriation efforts above these barriers are the responsibility of the Service. Effectiveness of these barriers is dependent upon Service commitment to ensure that these renovation and species repatriation efforts occur once barriers are in place.

For all of the barriers listed below, the following conditions apply. Siting and design will be subject to agreement among Reclamation and the Service, in consultation with AGFD. Reclamation will maintain these barriers over the 100-year life of the CAP. All of the barriers will be completed within 15 years from this consultation (March 2016) and a minimum of two barriers will be completed during each of the three consecutive five-year periods. Reclamation will make every attempt to complete these barriers in advance of this schedule, but due to a variety of factors beyond their control, may not be able to make that goal. If any of these barriers cannot be constructed due to factors outside Reclamation's control, an acceptable alternative barrier site will be agreed to in discussions with the Service. It is recognized here that reinitiation of formal consultation will not be necessary if a mutually agreeable site is selected, providing no effects to listed species will occur that are not already addressed by this biological opinion.

A single drop-type fish barrier will be constructed in the following locations:

– Verde River between the town of Clarkdale and the confluence with Sycamore Creek;

– Fossil Creek at one of the locations identified in Reclamation's November 2000 report entitled "Fossil Creek fish barrier phase I conceptual study;"
– Bonita Creek near its confluence with the Gila River;
– Hot Springs or Redfield Canyon (but not both) in their lower reaches;
– Blue River near its confluence with the San Francisco River, as identified in the February 1998 report "Blue River fish barriers feasibility study for Clifton Ranger District, U.S. Forest Service, Clifton, Arizona;"
– Tonto Creek basin at an as yet unidentified site, for replication of the East Fork White River population of loach minnow.

2. Monitoring. The purpose of monitoring is to establish baseline data on the presence and distribution of non-native fish in the target reaches and to detect changes in the species composition or distribution.

Reclamation will continue annual monitoring of the following waters of the Gila River basin throughout the expected 100-year life of the CAP:

– CAP aqueduct,
– Salt River Project canals,
– Florence-Casa Grande canal,
– Salt River between Stewart Mountain Dam and Granite Reef Diversion Dam and the electrical barriers,
– Gila River between Coolidge Dam and Ashurst-Hayden Diversion Dam,
– San Pedro River downstream of the U.S./Mexico border,
– Aravaipa Creek between the two Reclamation-constructed fish barriers (this area will also be monitored after major flooding events).

Monitoring will be conducted according to already established protocols (Clarkson 1996, Allison 2000). Any revisions of the monitoring protocol will be subject to review and concurrence by the Service in consultation with AGFD. Reclamation will notify the Service of any detection of a nonnative fish from an area where it had not previously been found, by telephone, within 5 days of the collection.

Reports of annual monitoring will be submitted to the Service and interested parties each year, and 5-year comprehensive reports that evaluate data trends will similarly be prepared and distributed. The first of these reports will be submitted in 2001.

3. Conservation of native fishes funding. The purpose of this funding is to achieve conservation actions (recovery and protection) for spikedace, loach minnow, Gila topminnow, razorback sucker, or other Gila River basin listed or candidate fish species by implementing, as much as possible, existing and future recovery plans for those fishes. The goal of the conservation actions is to achieve enhanced status for these species through recovery to compensate for threats from

the CAP that cannot feasibly be removed or prevented. However, it is recognized that Reclamation does not bear the responsibility for complete recovery of these species, since the CAP is not the sole, and may not be the most immediate, cause of their deteriorated status.

Reclamation will transfer to the Service annually for 21 years from the date of this consultation the sum of $250,000, plus an appropriate amount to cover Service administrative support costs (ranging from 0 to 20% depending upon the type of project). Expenditure of these funds will be jointly agreed upon by Reclamation and the Service in consultation with the Arizona and New Mexico Departments of Game and Fish. Fund transfers will occur within the first three months of each Federal fiscal year. The Service will submit an annual report to Reclamation detailing the expenditure of the funds and how they contributed to recovery of listed fish in the Gila River basin.

Under the terms of the 1994 biological opinion, no Service or Reclamation overhead charges were allowed from the reasonable and prudent alternative element 3 fund for conservation of native fishes. The first four years of funds under this reasonable and prudent alternative element have already been transferred to the Service. However, due to new policy, the Service is no longer allowed to expend funds received in fiscal year 2001 (October 2000 to October 2001) without charging overhead, which is expected to range from 0% to 20%. The fourth year's funds were received in December 2000. Although this biological opinion, and its provisions for overhead on years 5 through 25, supersedes the 1994 opinion, all of the fourth year's funds are earmarked for specific projects and none are available to cover the new overhead charges. Therefore, as part of the conservation measures, Reclamation has agreed to allow the retroactive overhead charges for the fourth year's funds to be taken from money allocated for Service coordination of fund implementation, provided that the reallocation does not impact the existing Intergovernmental Personnel Act agreement with Arizona State University. Those funds are identified as task 35 in the December 19, 2000 modification of the intra-agency agreement between Reclamation and the Service (#1425-97-AA-32-00420).

4. Control and management against nonnative aquatic species. The purpose of this funding is to accomplish research on, and control of, nonnative aquatic species. The goal of these actions is to directly control threats from CAP introduced or mediated nonnatives as well as to achieve enhanced status for Gila basin listed species through recovery to compensate for threats from the CAP that cannot feasibly be removed or prevented.

Reclamation will transfer to the Service annually for 21 years from the date of this consultation the sum of $250,000, plus an appropriate amount to cover Service administrative support costs (ranging from 0 to 20% depending upon the type of project). Expenditure of these funds shall be jointly agreed upon by Reclamation and the Service, in consultation with the AGFD and New Mexico Game and Fish (NMGF). Fund transfers will occur within the first three months of each fiscal year. The Service shall submit an annual report to Reclamation detailing the expenditure of the funds and how they contributed to nonnative aquatic species control and to recovery of listed fish in the Gila River basin.

Funding is to be used to help alleviate existing nonnative aquatic species threats in the Gila River basin, to remove nonnatives that may surmount fish barriers constructed by Reclamation, and to remove or control any nonnative species that may enter the basin via the CAP or other avenues. A portion of each year's funds for the first 10 to15 years will be retained by Reclamation to fund feasibility and design studies for recovery-oriented fish barriers in item 3, above.

These funds will also be applied to contingency actions for emergency needs in case of new incursions of nonnative aquatic species. During the consultation that resulted in the 1994 biological opinion, Reclamation and the Service agreed that this concept was to be part of the use of the funding under what was then reasonable and prudent alternative element 4; however, this was not specifically mentioned in the opinion. If such emergency needs arise, they will be diverted from this fund and the recovery fund, following agreement by Reclamation and the Service, in consultation with AGFD and NMGF. Experience from the four previous years has shown that unobligated funds are always available in these funds at any given time that could be reallocated for emergency actions on short notice. Reallocation would entail reprioritizing and delaying application of funds to projects previously identified, but should not otherwise create substantial difficulties.

The need for retroactive overhead charges to funding for year 4 of the fund for control and management against nonnative aquatic species (formerly Reasonable and prudent alternative element 4) is the same as addressed above under item 3 regarding funding for conservation of native fishes. Service overhead charges for year 4 of the funding for control and management against nonnative aquatic species will also be taken from task 35 of the December 19, 2000 modification of the intra-agency agreement between Reclamation and the Service (#1425-97-AA-32-00420).

5. Information and Education. The purpose of these actions is to increase public awareness of human-aided "bait bucket" transfers and pet-dumping avenues of nonnative aquatic species introductions and translocations and to increase awareness of, and support for, conservation of native fishes and their habitats, with emphasis on the problems nonnative aquatic species create for those species.

Reclamation will continue the 5-year program currently underway, in cooperation with AGFD. Reports on the progress and success of this program will be submitted annually to the Service.

II. STATUS OF THE SPECIES (Range-wide)

More in-depth information on the status of the species considered here, including citations of pertinent literature, is given in the background document. The following is a brief summary of that information.

Spikedace

Spikedace is a small fish listed as threatened since 1986. Critical habitat was designated in 2000 and includes portions of the Verde, middle Gila, San Pedro, San Francisco, Tularosa, Blue, and upper Gila Rivers and Eagle, Bonita, Tonto, and Aravaipa Creeks and several tributaries of those streams. Spikedace lives in flowing streams of moderate velocities over sand, gravel, and cobble substrates, using habitats where rapid flow borders slower flow. It spawns in spring, and eggs are laid over gravel and cobble where they adhere to the substrate. A spikedace lives about two years and eats primarily aquatic insects.

Spikedace was once found throughout most of the Gila River basin, but its range has been reduced by about 90%. The species' decline is due primarily to habitat destruction and alteration by human activities and by the introduction and spread of nonnative aquatic species. Spikedace now remains in limited portions of the Verde, middle Gila, and upper Gila Rivers, and Aravaipa and Eagle Creeks in Arizona and New Mexico. Remaining populations are genetically distinct. In its highly reduced remaining range, spikedace varies from common to rare. At present, the species is common only in Aravaipa Creek in Arizona and some parts of the upper Gila River in New Mexico. Populations in the Verde and Eagle Creek have not been found since 1999 and 1987, respectively, and their status is uncertain. The rangewide status of the species is poor and declining due to continuing habitat loss and nonnative species pressures.

Loach minnow

Loach minnow is a small fish listed as threatened since 1986. Critical habitat was designated in 2000 and includes portions of the Verde, Black, middle Gila, San Pedro, San Francisco, Tularosa, Blue, and upper Gila Rivers and Eagle, Bonita, Tonto, and Aravaipa Creeks and several tributaries of those streams. Loach minnow lives in shallow riffle areas of running streams, spending most of its time in cavities under, and in the lee of, rocks on the stream bottom. It spawns in spring and sometimes in autumn and adheres its eggs to the underside of the rock which forms the cavity. A loach minnow lives about two years and eats exclusively aquatic insects.

Loach minnow was once found throughout most of the Gila River basin, but its range has been reduced by about 85%. The species' decline is due primarily to habitat destruction and alteration by human activities and by the introduction and spread of nonnative aquatic species. Loach minnow remains in limited portions of the upper Gila, San Francisco, Blue, Black, Tularosa, and

White Rivers and Aravaipa, Turkey, Deer, Eagle, Campbell Blue, Dry Blue, Pace, Frieborn, Negrito, Whitewater, and Coyote Creeks in Arizona and New Mexico. Remaining populations are genetically distinct. In its highly reduced remaining range, loach minnow varies from common to rare. At present, the species is common only in Aravaipa Creek, the Blue River, and limited portions of the San Francisco, upper Gila and Tularosa Rivers. Remnant populations in the Black, White, and Eagle Creeks are very small and their continued existence is tenuous. The rangewide status of the species is declining due to continuing habitat loss and nonnative species pressures.

Gila topminnow

Gila topminnow is a very small fish listed as endangered since 1967. No critical habitat has been designated for the species. Gila topminnow lives in a variety of slow-water habitats in streams, springs, and marshes, tending toward protected areas associated with backwaters, vegetation, or debris. The historic habitat was much more widely varied than at present and historically the species had a pattern of large expansions and contractions of occupied areas in concert with environmental conditions. Gila topminnow is a live-bearer and produces young primarily in spring through autumn, although some reproduction may occur year-round, depending on conditions. A Gila topminnow lives about one year and is omnivorous.

The federally listed entity of Gila topminnow includes only that portion of its range in the United States. The omission of the Mexican portion of its range was based on legal and political considerations and was not related to biology or status (Weedman 1998). The United States portion of its range includes all of the Gila River basin, except small areas of the upper San Pedro and Santa Cruz drainages. Gila topminnow was once common throughout most of the mid to lower portions of the Gila River basin, but its range has been reduced to only 12 remnant populations. At least 175 sites have been stocked for recovery, but only 17 of these sites continue to support Gila topminnow. The species' decline is due primarily to habitat destruction, alteration, and fragmentation by human activities and by the introduction and spread of nonnative aquatic species. Gila topminnow natural populations now remain in three very small spring systems along the upper Gila River in Arizona, and at nine sites in the Santa Cruz River subbasin. Cienega Creek is the largest remaining population and is free of nonnative fish. Only two other remaining Gila topminnow populations are free of nonnative fish. The status of Gila topminnow rangewide is poor and declining due to continuing habitat loss and fragmentation and nonnative species pressures.

Razorback sucker

Razorback sucker is a medium sized fish listed as threatened since 1991. Critical habitat was designated in 1994 and includes portions of the Yampa, Green, White, Duchesne, Gunnison, Colorado, San Juan, Gila, Verde, and Salt Rivers in Colorado, Utah, New Mexico, and Arizona. Razorback sucker lives in slow currents, eddies, and backwaters of streams and also lives in reservoirs. It spawns in late winter and spring in shallow water on riffles or wave-washed shores over large gravel, cobble and coarse sand. Long spawning migrations have been documented. Razorback sucker lives about 50 years and eats plankton, algae, detritus and invertebrates.

Razorback sucker was once found throughout the low to mid elevations of the Gila River basin, but was extirpated from the basin by 1960. The species' decline is due primarily to habitat destruction and alteration by human activities and by the introduction and spread of nonnative aquatic species. Razorback sucker now occurs sporadically in several locations in the upper Colorado River basin and in three reservoirs and intervening river stretches in the lower Colorado River below the Grand Canyon. It has been reintroduced into a number of locations in the Gila River basin, most notably the Verde and upper Salt Rivers. The range-wide status of razorback sucker is extremely poor due to lack of significant recruitment, continued habitat loss, and continuing pressure from nonnative species.

Desert pupfish

Desert pupfish is a very small fish listed as endangered in 1986. Critical habitat was designated in 1986 and includes Quitobaquito Springs in Arizona and portions of San Felipe Creek and Carrizo and Fish Creek Washes in California. Desert pupfish lives in ponded or slow-flowing water in what was historically a wide variety of habitats including springs and marshes, small streams, and edges and backwaters of larger rivers. Remaining occupied habitats are small streams and springs. Desert pupfish spawns from spring through autumn, but may reproduce year-round depending upon conditions. Eggs are laid loose over soft substrates. A desert pupfish lives from 1 to 3 years and is omnivorous.

Desert pupfish was once common throughout the mid to lower portions of the Gila River basin, the lower Colorado River and its delta, and the Salton Sea basin of California. Desert pupfish was extirpated from the Gila basin by the mid-1900's. The Rio Sonoyta portion of what was originally considered to be desert pupfish has now been redescribed as a separate species and is not considered in our assessment of the status of desert pupfish. The only remaining natural populations of desert pupfish are isolated localities in the Salton Sea basin of California and the lower Colorado delta in Mexico. Attempts at stocking in the Gila River basin have been largely unsuccessful and only two populations are extant, both in small, isolated spring systems. The range-wide status of desert pupfish is poor but stable. The future of the species depends heavily upon future developments in water management of the Salton Sea and Santa Clara Cienega in Mexico.

Colorado squawfish

Colorado squawfish, also known as pikeminnow, is a large fish listed as endangered since 1967. Critical habitat was designated in 1994 and includes portions of the Yampa, Green, White, Gunnison, San Juan, and Colorado Rivers in Colorado, Utah, and New Mexico. Critical habitat was not designated in the Gila River basin because of a 1985 designation of the Salt and Verde Rivers as locations for experimental non-essential populations of Colorado squawfish. Such populations cannot be included in critical habitat. Colorado squawfish lives in the mainstream of larger rivers, with use of backwaters and eddies during some seasons and by young fish. It spawns in late spring through summer, making extensive migrations to appropriate shallow, coarse-bottomed habitat. Colorado squawfish is believed to live about 50 years and is carnivorous, eating mainly insects when young and fish when adult.

Colorado squawfish was once found in Gila, San Pedro, Salt, and Verde Rivers, but was extirpated from the basin by 1970. The species' decline is due primarily to habitat destruction and alteration, and fragmentation by human activities and by the introduction and spread of nonnative aquatic species. Colorado squawfish still occurs in several locations in the upper Colorado River basin. It has been reintroduced into the Gila River basin in the Verde and upper Salt Rivers, but with limited success. The range-wide status of Colorado squawfish is moderate due to limited recruitment, continued habitat loss, and continuing pressure from nonnative species.

Gila trout

Gila trout is a medium-sized fish listed as endangered in 1967. Critical habitat has not been designated. Gila trout lives in small headwater streams using pools for resting and riffles for feeding. It spawns in spring and early summer over gravel substrates. Gila trout feeds on aquatic invertebrates.

Gila trout was once common in the headwater streams of the upper Gila and San Francisco Rivers in New Mexico and the Verde and Blue Rivers in Arizona. By 1950, the species was confined to a few, severely fragmented, small headwater streams in the upper Gila and San Francisco Rivers in New Mexico. The species' decline is due primarily to habitat destruction and alteration and by the introduction and spread of nonnative aquatic species, particularly rainbow trout, which hybridize with Gila trout. A major effort to remove nonnative trouts and repatriate Gila trout in the upper Gila and San Francisco basins, and its reintroduction to the Verde and Blue River basins, has resulted in a range-wide status that is good and improving.

Apache trout

Apache trout is also a medium-sized fish listed as endangered in 1967, and reclassified to threatened in 1975. Critical habitat has not been designated. Apache trout lives in small headwater streams using pools for resting and riffles for feeding. It spawns in spring and early summer over gravel substrates. Apache trout feeds mainly on aquatic insects.

Apache trout was once common in the headwater streams of the Salt and Little Colorado River basins in the White Mountains of Arizona. By the time of its listing in 1967, it was reduced to only a few streams, although a restoration program was already underway by the White Mountain Apache Tribe. The species' decline is due primarily to habitat destruction and alteration and by the introduction and spread of nonnative aquatic species, particularly rainbow trout, which hybridize with Apache trout. Extensive hatchery propagation and repatriation efforts, combined with removal of nonnative trouts, has resulted in a range-wide status for Apache trout that is good and improving.

Bald eagle

Bald eagle, south of the 40th parallel, was listed as endangered in 1978, but was reclassified as threatened in 1995. Critical habitat is not designated. The Service is presently considering delisting of the species (USFWS 1999a). The southwestern, desert-nesting population of bald eagle nests along the larger rivers and streams of the Gila basin, using cliff ledges and pinnacles and large riparian trees and snags (cottonwood, willow, sycamore, juniper, pinyon and ponderosa pine). The bald eagle in the southwest lays eggs from December to March. After hatching, young remain associated with the nest and dependent on their parents for food into June and July before migrating north. Breeding eagles stay with their territories, for the most part, year-round. In addition to breeding eagles, the Gila basin also provides habitat for wintering bald eagles. Bald eagle feeds primarily on fish, but also eats birds, mammals, and other items.

Bald eagle historically nested along the Gila River and many of its tributaries. Yet, these records (from the late 1800's up through the 1960's) are sparse, and do not provide a clear description of the distribution and abundance of nesting Arizona eagles. Unfortunately, by the time of listing in 1978 (11 territories), the eagle's decline in Arizona and the Southwest can only be inferred through loss of habitat and better documentation of loss of nesting territories in other southwestern portions of the bird's range (southern California, Baja California, and western Texas). The primary causes for listing the eagle were loss of food resources, direct killing, loss of nesting habitat, and the widespread use of DDT (dichloro-diphenyl-trichloroethane) and other organochlorine insecticides; however it is unknown if bald eagle in Arizona declined as a result of DDT contamination because records were not consistently kept during this time period. Extensive recovery efforts have increased the southwestern nesting population to about 42 territories in Arizona and about 4 pairs in New Mexico (none exist in western Oklahoma and western Texas). The range-wide status of the species is good and improving, however, the status of the southwestern population still requires intensive management due to concerns in al` l portions of its breeding range regarding continuing habitat degradation and nesting disturbances.

III. ENVIRONMENTAL BASELINE

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

Action Area

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

General Environmental Baseline

The aquatic fauna and ecosystems of the Gila River basin have undergone dramatic changes over the past 150 years. Prior to the arrival of Europeans, Native Americans manipulated watersheds by use of fire and in some areas had extensive irrigation systems (Dobyns 1981, Tellman 1997). However, overall, the impacts to the aquatic systems were relatively minor and localized (Miller 1961, Minckley 1985, Bahre 1991). The Gila River and its major tributaries (except the Santa Cruz) were connected by perennial flow in all except the driest periods (Pattie 1962, Hastings and Turner 1980, Tellman 1997). The same connectivity occurred within the major subbasins and there was substantial opportunity for aquatic species to move between areas. Populations of fish or other aquatic species that were eradicated or highly depleted during periods of drought or other perturbation were recolonized from nearby areas (Minckley 1999).

With the arrival of Europeans, major alterations began in the Gila River basin. Beaver, which were a major influence on the structure of the Gila basin aquatic ecosystem were diminished almost to extirpation (McNamee 1994). The introduction of livestock began very early and has resulted in substantial alteration of the watershed and its soil and vegetation (York and Dick-Peddie 1969, Humphrey 1987, Bahre 1991). Croplands increased, often along river terraces, resulting in destabilization and erosion of floodplains (Leopold 1946, Rea 1983). Roads and trails caused extensive erosion and caused substantial destruction of river channels (Leopold 1921, Dobyns 1981, Rutman 1997). Diversion of water, which was already practiced by Native Americans in some areas, increased in those areas and was initiated in others (Tellman 1997). As diversion and irrigation increased, the demand for water storage increased, resulting in a variety of large and small dams and impoundments (Haddock 1980). By the mid 1900's, large stretches of river in the Gila basin no longer had perennial flow and the remaining areas were separated by long dry stretches, dams, and impounded water (Brown *et al*. 1978, Rea 1983, Hendrickson and Minckley 1984, Tellman 1997). As a result of these changes, the riverine habitats of the Gila basin became seriously fragmented and connectivity was substantially lost.

Populations of fish or other aquatic species eradicated by perturbation were not replaced by colonization. This fragmentation has been a major factor in the decline of almost all of Arizona's native aquatic fauna and has resulted in the typical pattern that presently exists, where native aquatic species, particularly the rarer of them, tend to be isolated in small headwater areas scattered across the outer reaches of the basin (Hendrickson and Minckley 1984, Minckley 1985).

However, this fragmentation also had some benefits to native aquatic species. While they were no longer able to move into other areas, the same impediments also inhibited the movement of nonnative fish and aquatic species. These nonnative species were imported by humans, starting with common carp in 1885 (Gilbert and Scofield 1898). Since that time, at least 50 species of nonnative fish have been introduced (AZ State Univ., Geographic Information Systems database of fish records 2001) into the Gila River basin, and there are other records of incidental occurrences of another 10 to15. Many nonnative invertebrates, amphibians, reptiles, plants, and disease organisms have also been introduced. These species have been purposefully introduced through sport, bait, biocontrol, and ornamental fish use and releases through aquaculture, aquarium, and generalized "bait bucket" activities. They have also been accidentally introduced through interbasin water transfers, aquarium and pet releases, and inclusion with other species being purposefully stocked. Nonnative aquatic species have had major detrimental impacts on native aquatic fauna and have been a major factor in the listing of spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, and Apache trout (Stefferud 1984, USFWS 1975, 1985a, 1986a, 1986b, 1986c, 1987, 1991). Species which depend upon the aquatic fauna, such as bald eagle, have also experienced serious adverse effects from nonnative aquatic species (AGFD 2000).

The CAP aqueduct spans the Gila River basin, crossing many of the major tributary systems (Figure 1). It forms a highway of perennial water stretching from the Colorado River through the center of the Gila basin and deep into the Santa Cruz subbasin. This perennial water highway reconnects the previously disconnected system, thus allowing movement of aquatic organisms from one part of the system to the other. Because of their severely reduced range and depleted condition, the native aquatic species are unlikely to benefit from this reconnection. However, the aqueduct will provide greatly enhanced opportunities for nonnative aquatic species to move between portions of the basin, particularly those species tolerant of a wide range of conditions.

The Gila River basin historically supported 18 species of fish (Minckley 1973). Of these, 1 is now extinct and 6 others have been extirpated from the basin, although 3 of those are being reintroduced with limited success. An additional 5 are listed as threatened or endangered and 1 is a candidate for listing. Of the remaining, 5 are "species of concern" with significantly decreased ranges and possibly declining populations, and 1 is a species with a much larger distribution elsewhere. Other aquatic fauna show a similar, but less dramatic, pattern. Of the 21 native amphibians in the Gila River basin, 1 has been extirpated from the basin, 2 are listed or proposed for listing as threatened or endangered, 1 is a localized endemic being protected via a conservation agreement in-lieu of listing, and the 2 others are "species of concern." The environmental baseline for all aquatic fauna in the Gila River basin is seriously deteriorated. Habitat destruction and alteration and nonnative species appear to be resulting in the collapse of entire western aquatic faunas (Williams *et al*. 1988, Minckley and Douglas 1991).

Further information on the environmental baseline can be found in the background document, along with more citations of pertinent literature.

Status of the Species (within the Action Area)

More detailed information on the status of each of the nine species considered in this opinion is found in the background document.

The status of spikedace and loach minnow within the action are identical to their range-wide status. The Gila basin, excluding the Santa Cruz River subbasin, coincides completely with the range of the two fishes. The population of spikedace in the middle Gila River, and the populations of spikedace and loach minnow in Aravaipa Creek and their designated critical habitat in the San Pedro River basin are within the most likely areas to be invaded by nonnative aquatic species introduced or spread via CAP. Populations and critical habitats in the upper Verde, Gila, San Francisco, Blue, and Black drainages are upstream of one or more mainstem dams from the aqueduct. Over the 100-year life of the project, repatriation of spikedace and loach minnow is expected to occur in areas throughout the Gila basin, primarily in the areas of designated critical habitat. The likelihood of direct and indirect effects from CAP-mediated nonnative species varies greatly among those areas. The status of spikedace and loach minnow within the action area is poor and declining with nonnative aquatic species being one of the major factors. Nonnative species pressures in some areas, such as the upper Verde River, may already be at levels lethal to spikedace and loach minnow survival and no increases can be tolerated.

The status of Gila topminnow within the action area is substantially different than its range-wide status. Most of the remaining natural populations are in the Santa Cruz subbasin, which is excluded from the action area of this consultation. Within the action area, only three natural populations exist, at the Bylas Springs complex on the San Carlos Apache Reservation. The complex consists of three very small spring systems that are periodically contaminated with nonnative mosquitofish (Marsh and Minckley 1990). Repeated efforts have been made to remove the mosquitofish, with variable success (Meffe 1983, Schleusner 2000). Barriers to reinvasion from the nearby Gila River are difficult to maintain due to the very even topography and soft alluvial soils. The future of these populations, which represent the only remaining portion of the Gila River basin Gila topminnow, outside of the Santa Cruz subbasin, is very precarious. Seventeen repatriated populations of Gila topminnow are known to be present in the Gila River basin, outside of the Santa Cruz subbasin (Weedman and Young 1997). Of those, two are contaminated with nonnative species. The status of the species is undetermined at another 63 sites that were stocked with Gila topminnow, and future augmentation of those populations is planned. Of those, about 15 already have some level of nonnative fish present. Other sites may be stocked with Gila topminnow as part of the recovery effort over the 100-year life of CAP. Many of the existing repatriated sites are in isolated waters that are never, or only extremely rarely, connected to other surface waters. However, about 25 of them are intermittently connected to other surface waters. Some of those have artificial or natural barriers to upstream nonnative fish movement, while others rely solely on the intermittency of the downstream flow to prevent incursion by nonnatives.

The status of desert pupfish within the action area is also substantially different than its range-wide status. Only two populations of desert pupfish in the "wild" are found within the action area and both were stocked for recovery. No native populations of desert pupfish remain in the Gila basin (Marsh and Sada 1993). One of the existing populations is semi-captive and is located in a small impoundment at Boyce-Thompson Arboretum, near the town of Superior. Both are small habitats. The Boyce-Thompson site is contaminated with fathead minnow, a nonnative fish. The other population is in Cold Spring Seep, a modified spring complex along the northern Gila River escarpment, just west of the town of Safford. Red shiner have been found in Cold Spring Seep, apparently a bait bucket introduction, but appear to have been successfully removed. Neither population is considered to be secure. Additional stocking of desert pupfish for recovery in the Gila basin is expected over the 100-year project life of CAP. Those sites are expected to have varying degrees of connectivity to other surface waters. The desert pupfish has been extirpated from the Gila basin and the repatriated populations have a very low rate of success.

Like desert pupfish, razorback sucker was extirpated from the Gila River basin and exists there now only as repatriated populations. The primary reintroduction efforts are in the Salt and Verde Rivers, but razorback sucker has also been reintroduced into the Gila, Black, Blue, East Verde, and San Francisco Rivers and Cherry, Coon, Canyon, Carrizo, Cedar, Tonto, Fossil, Oak, West Clear, Beaver, Sycamore, Eagle and Bonita Creeks (Hendrickson 1993). The survival of these reintroductions has been very low and no reproduction has yet been documented (AGFD 1998). Future stocking efforts are expected to focus on the Salt and Verde Rivers and the Gila River, above Coolidge Dam, but may be expanded to include other areas, such as the San Pedro River. The status of the species within the action area is very precarious.

Within the action area, Colorado squawfish exists only as repatriated populations in the Salt and Verde Rivers designated as experimental nonessential. The survival of these reintroductions has been very low and no reproduction has yet been documented (AGFD 1998). Reintroductions have also been made to the East Verde River and Canyon, Cherry and West Clear Creeks, but none of these are believed to have survived (Hendrickson 1993). Although the status of this species within the action area is very tenuous in the Gila River basin, which forms a substantial portion of the species' historic range, the most likely areas for recovery have been declared to not be essential for the long-term survival of the species.

The range of Gila trout is entirely contained within the Gila River basin, so that its status range-wide is equivalent to that in the action area. Natural and repatriated populations in the tributaries of the upper Gila and San Francisco Rivers are near the top of the watershed, but have only one intervening large dam between them and the CAP. All of the others have natural or constructed barriers near their downstream limits. Repatriated populations in Arizona are located in Dude Creek, a tributary of the East Verde River and Raspberry Creek, a tributary of the Blue River. Additional repatriation efforts are expected in headwater streams in the Verde, Blue, and Eagle Creek drainages. Within the action area, the status of Gila trout is good and improving, due to extensive recovery efforts that are primarily removal and prevention of invasion of nonnative fish.

Apache trout within the action area are found in headwaters of the Salt River system. This includes 12 natural populations and 9 replication populations. These populations are at the uppermost ends of the action area with a number of intervening dams along the Salt River that separate them from direct influence from CAP mediated nonnative aquatic species. Their status is equivalent to range-wide status, which is good and improving.

As described under the range-wide status, above, bald eagle south of the 40^{th} parallel have a significantly different status than for the species as a whole. With the exception of nesting eagles in the Bill Williams and Rio Grande drainages, the southwestern population is contained within the action area. Of the 42 territories in Arizona, 39 of them are in the Gila basin. Some of these territories are on waters that may be directly impacted by nonnative species introduced or spread via CAP. The most direct is the territory at Lake Pleasant, where stored CAP and Agua Fria water mix. The territories along the lower Salt and Verde Rivers and the middle Gila River are also on waters within direct reach of nonnatives moving out from CAP, with potential ramifications to the eagles. The status of the bald eagle in the action area has improved over the last three decades. Intensive management has helped prevent localized activities from disrupting nesting. Yet, riparian habitat loss continues on the lower Verde and Salt Rivers as a result of dam operations, livestock grazing, wood cutting, vehicle use in the floodplain, and agriculture. At Lake Pleasant, the situation has improved since the construction of New Waddell Dam, thus increasing the size of the lake and bald eagle food supply, but recreational use of the area is heavy and its impacts to the eagle are of concern.

For all of the above 9 species, controlling the nonnative species threat is essential, in varying degrees, to the survival of the species. This includes 1) stabilizing the existing nonnative aquatic species component in the listed species habitats through prevention of introduction and spread of nonnative species into previously unoccupied areas, and 2) removing or reducing existing nonnatives species populations. Even for the listed species in good and increasing status, failure to accomplish these objectives is likely to result in eventual extirpation and/or extinction.

Section 7 Consultation Environmental Baseline

All of the species considered in this opinion have been adversely affected by Federal actions that have undergone informal and formal section 7 consultation on actions that contribute to the degraded environmental baseline. Two categories of consultation are of particular interest to this analysis. The first are those consultations that have been conducted on Federal actions that would result in, or encourage, introduction and spread of nonnative aquatic species in the Gila River basin. A list of the 9 formal and 6 informal consultations is found in the background document. Although only 3 of the formal consultations have found the level of impact from that particular project to reach jeopardy (2 for bald eagle, 2 for Gila topminnow, and 1 for spikedace, loach minnow, and razorback sucker [USFWS 1983, 1984, 1985b, 1994]) the incremental addition of adverse effects from these actions has contributed to the continued decline of spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, and the bald eagle (in the Gila River basin). Some incremental effects to Apache and Gila trout have been incurred, but have been sufficiently counteracted by other recovery efforts, enabling the upward trend in those species' status.

The second category are those consultations that have been conducted on various aspects of the CAP. A list of those consultations is found in the background document. There have been 17 formal biological opinions and approximately 45 informal consultations conducted on CAP. Despite that, many aspects affecting how nonnative aquatic species are introduced and spread through CAP were not subject to section 7 analysis on that issue prior to 1994. By 1994, major CAP actions, such as the construction of the aqueduct from Lake Havasu to the Casa Grande Extension, had already been completed and could no longer be the subject of direct consultation on the issue of nonnative species. Other events, such as the 1993 transfer of operation and maintenance of CAP to CAWCD, removed significant aspects of the project affecting how nonnative species are introduced and spread from direct analysis under section 7 by removing Federal discretion. The transfer to CAWCD, which occurred midway through the 1991-94 consultation, resulted in substantial change in how CAP effects could be considered between the 1991 analysis revealing jeopardy and the 1994 reasonable and prudent alternative removing jeopardy. Because the 1991-94 consultation was based on a substantially completed action for which a major portion of the discretionary Federal authority had been irrevocably transferred, the ability to develop a reasonable and prudent alternative that would remove jeopardy and adverse modification was impaired. If consultation on nonnative species issues through CAP had been conducted earlier in the development of CAP, a wider range of alternatives for removal of threats may have been available. Although none of these considerations are a part of the CAP action now under consultation, these past Federal actions are a part of the environmental baseline that has contributed to the degraded status of the nine species considered here.

IV. EFFECTS OF THE ACTION

The analysis of the potential for CAP to introduce and spread nonnative aquatic species in the Gila River basin, and thereby affect the nine species addressed in this biological opinion, is lengthy and complex. Therefore, the following discussion is a summary of that analysis. Data and information used and additional review of the supporting literature can be found in the background document.

The effects of CAP to the nine listed species is additive to the already highly deteriorated environmental baseline of the Gila River basin aquatic ecosystem. The status of most of the nine species is poor and declining. Remaining habitats are highly altered, making many of them conducive to colonization by nonnative species, which may be able to use different habitats than the natives. Many of the former habitats of the eight fish are now occupied by nonnative species to the exclusion of any occupation by the native species. Unless nonnative aquatic species can be controlled and further incursions prevented, recovery is not likely for any of these species and their continued existence may be in peril. For the bald eagle, the southwestern population could suffer declines from existing levels if nonnative aquatic species that are deleterious to their preferred prey, which includes nonnatives, are not controlled.

Nonnative aquatic species include fishes, aquatic and semi-aquatic mammals, reptiles, amphibians, crustaceans, molluscs (snails and clams), insects, zoo- and phytoplankton, parasites, disease organisms, algae, and aquatic and riparian vascular plants. They may affect native fish and other aquatic fauna, including the eight fish species considered in this opinion, through predation (Meffe *et al*. 1983, Meffe 1985, Marsh and Brooks 1989, Propst *et al*. 1992, Rosen *et al*. 1995, Rinne 1999), competition (Schoenherr 1974, Lydeard and Belk 1993, Baltz and Moyle 1993, Douglas *et al*. 1994), aggression (Meffe 1984, Dean 1987), habitat disruption (Hurlbert *et al*. 1972, Ross 1991, Fernandez and Rosen 1996), introduction of diseases and parasites (Sinderman 1993, Clarkson *et al*. 1997, Robinson *et al*. 1998), and hybridization (Dowling and Childs 1992, Echelle and Echelle 1997). They may affect native fish-eating species, including bald eagle, through alteration of their food base (AGFD 2000, McClelland *et al*. 1983, Claudi and Leach 2000). Nonnative plants can reduce available habitat with abundant growth (e.g. water cress), potentially cause loss of surface water (e.g. salt cedar), or alter ecosystem dynamics (McKnight 1993, Stromberg and Chew 1997, Lovich and DeGouvenain 1998).

All of the nine listed species are highly vulnerable to adverse effects from nonnative aquatic species. The Gila basin had a naturally depauperate aquatic fauna and native aquatic species, including the eight fish considered here, did not evolve with any significant predation or competition (Carlson and Muth 1989). This evolutionary history makes them highly vulnerable to adverse effects from nonnative species. The bald eagle, although it will readily use many nonnative fish as food, may be adversely affected if the fish fauna becomes dominated by nonnative species less available to capture, such as has occurred with flathead catfish replacement of native fishes in the upper Salt River (AGFD 2000). It may also be affected if nonnative-induced habitat changes make prey capture problematic, such as if giant salvinia reaches Lake Pleasant and covers the reservoir to the level experienced elsewhere (USGS 2001). Giant salvinia is a floating plant recently introduced into the Colorado River and which has a very high likelihood of entering the CAP aqueduct in the near future. For more information on giant salvinia, see the background document.

Introduction and spread of nonnative species is among the most serious and rapidly growing environmental problems today (Elton 1958, MacDonald *et al*. 1986, Coblentz 1990, McKnight 1993, Rosenfeld and Mann 1992, Simberloff *et al*. 1997, Claudi and Leach 2000). It is documented as a factor adversely affecting bald eagle in portions of its range in the southwest and elsewhere (McClelland *et al*. 1983, AGFD 2000, Claudi and Leach 2000). It is also well documented as a major factor in the decline of southwestern native fishes, including the eight considered in this opinion (Miller 1961, Propst *et al*. 1986, Propst *et al* 1988, Carlson and Muth 1989, Miller *et al*. 1989, Aquatic Nuisance Species Task Force 1994, Cohen and Carlton 1995, Lassuy 1995). Minckley (1991:145) succinctly summarized the situation for the aquatic fauna when he said "Native fishes of the American West will not remain on earth without active management, and I argue forcefully that control of nonnative warmwater species is the single most important requirement for achieving that goal."

CAP is an interbasin water transfer that will, like most interbasin water transfers, transport nonnative species across basin and subbasin boundaries (Davies *et al*. 1992, Meador 1992, 1996, Stefferud and Meador 1998, Claudi and Leach 2000) (see Table 4). CAP has already transported nonnative striped bass into the Gila basin (AGFD unpub. data) and likely already has, or soon will, introduce Asian clam into the Santa Cruz subbasin (USFWS 1999b). In addition to direct transport of nonnative aquatic species, the CAP system provides a means of spread for species introduced through aquaculture, the aquarium trade, sport fish stocking, biological control, and bait-bucket transfer (Figure 3). Unauthorized stocking and "bait bucket" spread of species by the public is significantly increased by CAP through increased access by the public to nonnative species and to open waters, such as the aqueduct, recharge projects, created wetlands, and other features of CAP (Claudi and Leach 2001). Aquatic habitats created by CAP water, or water made available by other use of CAP water, provide enhanced habitat and opportunities for stocking nonnative aquatic species Nonnative grass carp and mosquitofish have already been introduced directly into the CAP and interconnected features (such as recharge areas) for biological control, and introduction of black carp has been proposed (Bawden 1994, FWS unpub. data, J.Garza, CAWCD, pers. comm., Oct. 1997). Due to objections by the Service and Reclamation, that proposal has since been dropped (CAWCD 2001). Aquaculture in the aqueduct has been considered, but is not planned at the present time.

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

CAP has a project life of 100 years. Over that lengthy period the Service is certain that more than the 1 to 2 species that have already moved via CAP, will be introduced or assisted in their spread by CAP. CAP is an aquatic “highway” reconnecting human-isolated fragments of the Gila basin surface water and substantially enhancing the ability of aquatic species to move throughout the system. This connection will not benefit native fish, but will benefit nonnative aquatic species by providing enhanced opportunities for movement between the Colorado River and Gila basin and between subbasins of the Gila River.

Over the 100-year project life substantial changes are expected in the project, including water use, technology, human population, available nonnatives, climate trends, and other factors. Therefore, this analysis uses a broad scale approach, focusing on existing data on movement of species already occurring through the CAP aqueduct and connected canal systems (Grabowski *et al*. 1984, Mueller 1989, 1997, Clarkson 1998,1999, and 2001, Bettaso 2000) (Table 5) and through other interbasin water transfers (Table 4). In addition, we assessed information on existing specifics of CAP and the Gila River basin aquatic ecosystem to determine that nothing about CAP indicates it is sufficiently different from other interbasin water transfers to support a presumption that it would not fit into the general pattern illustrated in Table 4. Although significant impediments to species movement through the CAP system exist (CAWCD 1995) they do not prevent such movement (e.g. striped bass, white bass, Asian clam) nor are they any greater than those overcome by species moving through interbasin water transfers elsewhere (Rubinoff and Rubinoff 1968, Guiver 1976, Laurenson and Hocutt 1985, Swift *et al*. 1993).

Nonnative species are extremely hard, if not impossible, to remove once established (Aquatic Nuisance Species Task Force 1994). If possible, control or removal can be costly, such as the predicted annual costs of $90 million for ruffe control (Great Lakes Fishery Commission 1992, as cited in Courtenay 1995). It may also entail use of toxic substances that may be unpopular with the public and may affect many species besides the target nonnative (DeMarais *et al*. 1993, Inchausty and Heckmann 1997, Finlayson *et al*. 2000). Therefore, survival and recovery of the spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Apache trout, and Gila trout, and the continued success of bald eagle, require proactive prevention of the invasion or spread of nonnatives to the maximum extent possible.

Spikedace, loach minnow, Gila topminnow, razorback sucker, and bald eagle are all expected to be seriously adversely affected by introduction and spread of nonnative aquatic species through the CAP. The degree of vulnerability of their populations and presently unoccupied recovery areas to CAP mediated nonnatives is variable. Some, such as Aravaipa Creek and those in the middle Gila River above Ashurst Hayden Dam are close to, and have direct routes from, the CAP aqueduct. Others, such as those in the upper Salt River drainage, have a number of dams intervening between that area and the aqueduct and will be affected by CAP only indirectly through nonnative spread due to bait bucket transport of species made more accessible by CAP, or by species that can move overland and use CAP as a staging area in their colonization efforts. The four fish live primarily in medium-to-warmer water habitats that are likely to be successfully colonized by nonnative aquatic species moving out from the CAP aqueduct or its related facilities. The nesting population of bald eagle in the Gila basin lives, and feeds on fish, along similar warmer water habitats.

For spikedace, loach minnow, and razorback sucker, their critical habitat is also expected to be seriously adversely affected by introduction and spread of nonnative aquatic species through CAP. Where critical habitat is occupied, the effects would be commensurate with effects to the species itself. Where critical habitat is designated for recovery areas that are expected to be enhanced and stocked with repatriated populations, the adverse effects from nonnative species could be sufficiently adverse to preclude successful repatriation and recovery.

No natural populations of desert pupfish are located within the action area, one of the two repatriated existing populations is an isolated spring, and the other is above a small dam. Most areas in which repatriation is likely to occur are similarly isolated, although some may be connected to other surface waters. Although the two existing repatriated populations are the only ones of this species in the entire Gila basin, the potential for adverse effects from CAP-mediated nonnative aquatic species is expected to be very small. However, some aquatic species dispersing via CAP, such as giant salvinia, might have a substantially increased likelihood of reaching these habitats once introduced into the Gila basin through the CAP aqueduct.

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

The conservation measures that Reclamation has included with the proposed action for CAP in the Gila River basin will substantially alleviate threats from introduction and spread of nonnative aquatic species via CAP. Direct threat removal will occur through barriers on Aravaipa Creek and the San Pedro River plus monitoring and management against nonnative species, and the information and education program will help alleviate the indirect threat from “bait-bucket” transfers associated with CAP waters and CAP introduced species. However, not all threats will be removed. Significant areas where threats are not ameliorated by the conservation measures include the middle Gila River above Ashurst-Hayden Dam, which is directly connected to the CAP aqueduct through the Florence-Casa Grande Canal, and that portion of nonnative aquatic species that may be introduced and spread through CAP that are not fish (i.e. invertebrates, amphibians, plants, pathogens). Monitoring under the conservation measures is exclusively focused on fish, and the barriers are designed to prevent fish movement, but not necessarily that of non-fish species.

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

The conservation measures proposed will provide significant assistance in the recovery programs for spikedace and loach minnow, although localized, short-term adverse effects may occur during barrier construction in occupied streams. The benefits will be slightly less for razorback sucker and Gila topminnow, although important recovery actions for both species will occur through the recovery and nonnative management funds, as evidenced by the history of the first four years of implementation of those funds. Desert pupfish, Gila trout, and Apache trout may all benefit from some recovery actions through the recovery and nonnative management funds of the conservation measures. However, due to the low likelihood of adverse effects from CAP-mediated nonnatives, use of funds for those species is expected to be minor.

Bald eagle will benefit from the conservation measures primarily from the nonnative management efforts. Some of the barriers will provide protection to bald eagle, such as the Verde River barrier, which is downstream of two existing bald eagle nesting territories. If any of the barriers are built close to nesting territories, some localized and short-term adverse impacts may occur. Other than the projects aimed at general nonnative species control, bald eagle is not included in projects funded under the recovery and nonnative species management funds.

It must be recognized that although the barriers to upstream fish movement are a major part of the benefits of the conservation measures, if those barriers are not accompanied by appropriate management action there is the potential that the barriers may result in adverse effects. Barriers fragment populations and prevent upstream emigration (Sloat 1999). On streams where some level of nonnatives already exist upstream, barriers can, under some circumstances, enhance the likelihood of the nonnatives becoming predominant. This is particularly likely when a healthy population of nonnative species exists downstream that may augment the upstream area. To ensure benefits from the barriers, in most circumstances they must be accompanied by control of nonnatives upstream. Because the nonnative species removal and repatriation of native species is outside the authority of Reclamation, the success of the barriers depends heavily on implementation of those management actions by the Service and other appropriate entities. The Service is committed to ensuring expeditious and successful completion of those actions, which are necessary to implement the recovery plans for the listed fish considered in this biological opinion. However, the conclusions of this consultation regarding CAP and the extent of

Reclamation's responsibility under this consultation are independent of any delays or impediments to implementation or effectiveness of those actions.

Delays experienced during the 1994-2000 implementation of the reasonable and prudent alternative are of concern and may have resulted in small increases in the risk to listed species from CAP introduced and spread nonnative aquatic species. However, those delays are not believed to have significantly changed the capability of the reasonable and prudent alternative to remove the threat of jeopardy and adverse modification of critical habitat. Although any harm incurred as a result of the delays cannot be undone, the additional barriers proposed as part of the conservation measures will compensate through increased recovery of the listed species. Providing that no significant additional delays occur in implementation of the conservation measures, and that the extended time periods for construction of the San Pedro River barrier and modification of the existing electrical barriers are met, the conservation measures are expected to sufficiently remove the threat of jeopardy and adverse modification of critical habitat.

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

VI. CUMULATIVE EFFECTS

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

The largest cumulative effects will result from the operation and maintenance of CAP by CAWCD, a State entity (see earlier discussion under interrelated and interdependent actions). The CAP was built for the purpose of delivering water to users in central and southern Arizona. Therefore, it is reasonably foreseeable that such deliveries will continue throughout the 100-year life span of the project. The Federal actions that are under consultation here are limited to specific aspects of the CAP facilities and operation (see Table 1). CAWCD's ongoing operation and operation and maintenance are considered in the analysis of effects to listed species as cumulative to the Federal action. Because of the difficulty in describing the CAP system in separate pieces depending upon Federal, State, or private responsibilities, the CAWCD actions that will result in cumulative effects are incorporated in the overall project description section of this biological opinion.

Private actions using CAP water are also cumulative to the Federal action involved in CAP (see earlier discussion under interrelated and interdependent actions). The use of CAP water for agricultural, municipal and industrial, Indian, and recharge purposes may change significantly over the course of the 100-year project life, but is not expected to cease or decrease. Therefore it is a reasonably foreseeable action, the effects of which must be considered in the analysis conducted in this biological opinion. As with the CAWCD cumulative actions, the private actions in direct use of CAP water are described as part of the earlier overall project description section of this biological opinion.

Various non-Federal actions in addition to those from direct use of CAP water are also cumulative to the CAP impacts to nine listed species. Human population growth in the Gila River basin, particularly in the Phoenix and other urban areas, is predicted to occur into the future (ADES 2001) and will place greater demands on all natural resources in the basin, especially water. Growth and development will continue to result in changes in watershed condition and watershed functioning affecting water quality and quantity, riparian vegetation, channel morphology, and flood characteristics. Groundwater pumping and other water development in outlying areas, particularly where related to CAP allocation exchanges, will result from the increased population growth fueled by CAP. Groundwater pumping in areas such as the upper San Pedro and the Prescott/Chino Valley area threaten the water supply of streams important to spikedace, loach minnow, Gila topminnow, razorback sucker, and bald eagle. As more people live and recreate in the area, opportunities will also increase for nonnative aquatic species to enter the basin. Illegal releases of nonnative organisms will continue and increase (Aquatic Nuisance Species Task Force 1994 Rosen *et al*. 1995) as will the demand for stocking of nonnative sport fish by AGFD (USFWS 2000b). Use of nonnative organisms as pets may also increase, as will illegal release of those organisms (Moore *et al*. 1976, Shelton and Smitherman 1984, Welcomme 1988).

Additional information on cumulative effects can be found in the background document.

V. CONCLUSION

After reviewing the current status of each species, the environmental baseline for the action area, the effects of the proposed action and the interrelated and interdependent actions, and the cumulative effects, it is the Service's biological opinion that the CAP in the Gila River basin, with the implementation of the proposed conservation measures, is not likely to jeopardize the continued existence of spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Apache trout, Gila trout, or bald eagle or to destroy or adversely modify the critical habitats of spikedace, loach minnow, razorback sucker, or desert pupfish.

After reviewing the current status of each species, the environmental baseline for the action area, the effects of the proposed action and the interrelated and interdependent actions, and the cumulative effects, it is the Service's conference opinion that the CAP in the Gila River basin, with the implementation of the proposed conservation measures, is not likely to jeopardize the continued existence of the experimental nonessential populations of Colorado squawfish.

INCIDENTAL TAKE STATEMENT

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

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

AMOUNT OR EXTENT OF TAKE

Spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, and Apache trout

Take is anticipated to occur through direct mortality to adult, juvenile, and larval fish and their eggs (except for Gila topminnow which is a livebearer) due to predation and harassment by nonnative aquatic species introduced or spread via CAP; to introduction of nonnative parasites and disease organisms; and by construction and maintenance of fish barriers. Any fish or their eggs in the construction area of the fish barriers are anticipated to be killed when crushed by equipment, stranded during flow diversion, exposed to toxic materials such as petroleum products, or smothered by sediment input. Direct take as a result of nonnative species removal projects is not considered here. Such projects will require additional section 7 consultation.

Take of adult, juvenile, and larval fish may occur in the form of harm from competition for food or habitat with nonnative aquatic species from CAP resulting in decreased health, shorter life spans, decreased reproduction, increased loss from predation, and other impairments of breeding, feeding, and sheltering. Take may also occur as a result of habitat or community alteration by CAP introduced or spread nonnative aquatic species, thus disrupting and impairing breeding, feeding, and sheltering. During fish barrier construction, take may also occur due to destruction or alteration of habitat resulting from modification or destabilization of the substrate, channel, streambanks, and riparian vegetation. Such habitat loss would alter behavioral patterns, food availability, access to cover, and availability of habitat, thus reducing survival of individual fish and potentially reducing or precluding reproduction.

The anticipated amount of take from nonnative species cannot be directly quantified. It will be highly variable over time and space, ranging from a few listed fish per year up to, and including, entire populations of each species. Only a portion of the nonnative species that may invade can be identified at this time and the timing of the invasions during the 100-year project duration are unpredictable. In addition, population levels of the listed fish cannot be accurately described with existing information and techniques and for the shorter-lived species may vary substantially from year to year and season to season. Fish consumed by predation cannot be detected, individuals dead from incidental take are difficult to find and the cause of their death may be difficult to determine, and losses in population may be masked by fluctuations in numbers that are natural or caused by other factors. The anticipated level of take from barrier construction is also unquantifiable because the specific location of the barriers are currently unknown, and because of the technical difficulties in determining population numbers and mortalities, difficulties in detecting dead or dying individuals, natural population fluctuations, and confounding natural and human-caused factors. The species which may be taken will vary from barrier to barrier. Desert pupfish and Apache trout are not expected to be taken as a result of barrier construction. Therefore, anticipated take of these species is indexed to the project itself for nonnative species and for barrier construction it is indexed to the total fish community and habitat. Anticipated take for spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout and Apache trout will be considered to have been exceeded if any of the following conditions occur:

1. If at any time during the 100-year life of CAP, the conservation measures are altered or not carried out as characterized in this biological opinion.

2. If at any time during barrier activities (including pre-construction, construction, and maintenance), any one or more of the following conditions occur:

   2.1 More than 20 dead fish of any species are found in the area of barrier construction activities or within 500 yards (460 meters) downstream. The purpose of this condition is to detect, and control, events that result in substantial acute mortalities in the aquatic faunal community, such as a spill of toxic materials.

   2.2 Any spill of toxic materials occurs in the channel or on the floodplain of the stream in which the barrier is being constructed. This does not include concrete being poured for the barrier.

   2.3. Barrier construction activities exceed the bounds of the anticipated disturbance area for that particular barrier, as determined by Reclamation, with Service concurrence, prior to construction initiation.

<u>Bald eagle</u>

Take of bald eagle is anticipated, in the form of harm, through alteration of the quantity and quality of the food base which impairs feeding. Take may also occur if nonnative species, such as giant salvinia, hinder accessibility of fish to eagle capture.

Construction and maintenance of fish barriers on the upper Verde River and lower Fossil Creek, where eagle territories are nearby and wintering eagles exist, may result in take of bald eagles through harassment or harm by hindrance of access to feeding areas, and other disruptions of breeding, feeding, or sheltering. Take as a result of nonnative species removal projects is not considered here. Such projects will require additional section 7 consultation.

The level of take from nonnative introduction and spread is not quantifiable at this time because it is indeterminable what the cause and effect relationship may be to eagle populations from the future introduction of a nonnative aquatic organism (i.e. plants, vertebrates, invertebrates). Although some level of take can reasonably be expected to occur, the level could range from insignificant to catastrophic, depending on what type of nonnative organism enters the streams and waters where eagles are located. Thus, the identification of a new nonnative species to these systems presents a danger/risk that if not immediately ameliorated could result in excessive take. Therefore, anticipated take of bald eagle is indexed to the project itself. Anticipated take of bald eagle will be considered to have been exceeded if either or both of the following two conditions occur:

1. If at any time during the 100-year life of CAP, the conservation measures are altered or not carried out as characterized in this biological opinion.

2. If at any time during barrier activities (including pre-construction, construction, and maintenance) on the Verde River and Fossil Creek, any of the following conditions occur:

    2.1 The site selected for either barrier is closer than 1 mile (1.6 kilometers) to an active bald eagle nest site (January 1 through June 30) or a known bald eagle nest during the pre-nesting phase (December 1 through February 28).

    2.2 Barrier construction activities exceed the bounds of the anticipated disturbance area for that particular barrier, as determined by Reclamation, with Service concurrence, prior to construction initiation.

    2.3 Barrier activities require use of helicopters within a 1 (1.6 kilometers) mile horizontal radius of or 2000 feet (610 meters) above an active bald eagle nest site (January 1 through June 30) or a known bald eagle nest during the pre-nesting phase (December 1 through February 28).

The Service will not refer the incidental take of the bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§703-712), or the Bald and Golden Eagle Protection Act of 1940 (16 U.S.C. §668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

If, during the course of the action, the amount or extent of the incidental take anticipated is exceeded, Reclamation must reinitiate consultation with the Service immediately to avoid violation of section 9. Operations must be stopped in the interim period between initiation and completion of the new consultation, if it is determined that the impact of the additional taking would cause an irreversible and adverse impact on the species. Reclamation should provide an explanation of the causes of the taking.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, Apache trout, or bald eagle or to adversely modify the critical habitat of any of those with such designations.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the incidental take authorized by this biological opinion.

Spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, and Apache trout

1. The Service believes the conservation measures of the proposed action include all measures necessary and appropriate to minimize take from that portion of the action related to nonnative aquatic species predation, competition, harassment, habitat alteration, and hybridization. Therefore no additional measures are provided.

2. For the take from that portion of the action related to implementation of the conservation measures, the Service provides the following reasonable and prudent measures:

   2.1 Conduct all proposed actions in a manner that will minimize direct mortality of spikedace, loach minnow, Gila topminnow, razorback sucker, Colorado squawfish, and Gila trout.

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

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

   2.4 Maintain complete and accurate records of actions which may result in take of spikedace, loach minnow, Gila topminnow, razorback sucker, Colorado squawfish, and Gila trout.

Bald eagle

1. The Service believes the conservation measures of the proposed action include all measures necessary and appropriate to minimize take from that portion of the action related to disruption of bald eagle feeding and productivity caused by changes in composition and availability of fish due to nonnative aquatic species. Therefore, no additional measures are provided.

2. For the take from that portion of the action related to implementation of the conservation measures, the Service provides the following reasonable and prudent measures:

2.1 Conduct all proposed actions in a manner that will minimize harassment, nest disruption or mortality of bald eagle.

2.2 Conduct all proposed actions in a manner that will minimize loss and alteration of habitat of bald eagle, including the aquatic faunal community that constitutes the food base.

2.3 Monitor the aquatic faunal community to document changes to bald eagle food base that may result in take.

2.4 Maintain complete and accurate records of actions which may result in take of bald eagle.

TERMS AND CONDITIONS FOR IMPLEMENTATION

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation is responsible for compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

<u>Spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, and Apache trout</u>

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

2. The following terms and conditions will implement reasonable and prudent measure 2

2.1 The following terms and conditions will implement reasonable and prudent measure 2.1.

2.1.1 All reasonable efforts will be made to minimize activities within the waters of the streams in which the fish barriers are constructed. This includes pre-construction investigations, barrier construction, and barrier maintenance, but does not include monitoring.

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

2.1.3 All reasonable efforts shall be made to ensure that no pollutants enter surface waters during any barrier investigation, construction, or maintenance activities. No toxic chemicals (including petroleum products) shall be stored or deposited within the floodplain. An appropriate spill response kit for cleaning up accidental releases of petroleum products (or other appropriate substances) will be available at the work site whenever work is ongoing, and at least one person present shall have training in use of that kit.

2.2 The following terms and conditions will implement reasonable and prudent measure 2.2.

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

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

2.2.3 All reasonable efforts will be made to minimize channel and floodplain alterations during barrier pre-construction, construction, and maintenance activities. Restoration plans for revegetation and recontouring the channel and floodplain will be prepared and implemented, with concurrence from the Service.

2.3 The following terms and conditions will implement reasonable and prudent measure 2.3.

2.3.1 At all times when barrier pre-construction, construction, or maintenance activities are ongoing, all reasonable efforts shall be maintained to monitor for the presence of dead or dying fish in, or within, 500 yards (460 meters) downstream of, the project area. The Service shall be notified immediately, by telephone, upon detection of more than 20 dead or dying fish of any species. Operations must be stopped in the interim period between the detection and determination and resolution of the cause of the mortalities.

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

2.4 The following term and condition will implement reasonable and prudent measure 2.4.

2.4.1. A written report shall be submitted to the Service annually documenting CAP activities for the year that might have resulted in take, including implementation of the conservation measures. The report will include a discussion of compliance with the above terms and conditions.

Bald eagle

1. Implementation of the conservation measures of the proposed action will constitute the terms and conditions implementing reasonable and prudent measure 1. This coverage assumes that the contingency planning to be undertaken under the funding for nonnative species management will include concerns for actions when bald eagle food base is threatened by introduction and spread of nonnatives.

2. The following terms and conditions will implement reasonable and prudent measure 2.

2.1 The following terms and conditions will implement reasonable and prudent measure 2.1.

2.1.1 Site selection for fish barriers on the Verde River and Fossil Creek will consider bald eagle and, if possible while still maximizing barrier effectiveness and stability, the site with the lowest impacts to eagles will be selected.

2.1.2 All reasonable efforts will be made to minimize activities at the Verde River and Fossil Creek barrier sites within the nesting season of bald eagle. This includes pre-construction and maintenance activities. It is recognized that barrier construction is a lengthy process and it may not be possible to avoid work during the entire eagle nesting period (December 1 to June 30). If construction is necessary during that period, Reclamation will work with the Service and AGFD to minimize disturbance to the bald eagles.

2.2 The following term and condition will implement reasonable and prudent measure 2.2.

2.2.1 Implementation of terms and conditions 2.1.1 through 2.1.3 for the eight fish will constitute the terms and conditions implementing reasonable and prudent measure 2.2.

2.3 The following term and condition will implement reasonable and prudent measure 2.3.

2.3.1. Implementation of the conservation measures of the proposed action will constitute the terms and conditions implementing reasonable and prudent measure 2.3.

2.4 The following term and condition will implement reasonable and prudent measure 2.4.

2.4.1 A written report shall be submitted to the Service annually documenting CAP activities for the year that might have resulted in take of bald eagle, including implementation of the conservation measures. The report will include a discussion of compliance with the above terms and conditions.

DISPOSITION OF DEAD OR INJURED LISTED ANIMALS

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

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

CONSERVATION RECOMMENDATIONS

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

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

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

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

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

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

4.   Expand the conservation of native fishes (recovery) fund, which as presently constituted addresses only actions for recovery of listed fish, to include bald eagle. To avoid reducing the amount of recovery that can be accomplished for the listed fish, the amount of funding should be increased to provide for recovery actions for the eagle.

5. Work with the Service and AGFD, to develop and implement, ways to minimize disturbance to bald eagles during nonnative aquatic species monitoring activities. Make all reasonable efforts to minimize harassment of breeding, foraging, sheltering, and perching eagles.

6. Add a fish monitoring site on the lower Verde River to the existing fish monitoring program being conducted under the conservation measures. This site should be located to best identify the presence of nonnative aquatic species that might result in changes to the bald eagle food base or its availability to the eagles.

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

REINITIATION NOTICE

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

We appreciate the efforts of Reclamation in working with the Service to preserve the native aquatic fauna of the Gila River basin. If we can be of further assistance, please contact Sally Stefferud or myself.

David L. Harlow

Attachment

cc: Director, Fish and Wildlife Service, Washington, D.C. (HC)
Regional Director, Fish and Wildlife Service, Albuquerque, NM
Field Supervisor, Fish and Wildlife Service, Albuquerque, NM

Project Leader, Fish and Wildlife Service, Pinetop, AZ
Regional Solicitor, Department of the Interior, Albuquerque, NM (Attn: Michael Schoessler)
Field Solicitor, Department of the Interior, Phoenix, AZ (Attn: Joan Card)
Dept. of Justice, Environmental and Natural Resources, Washington, D.C. (Attn: Sam Rauch)
General Manager, Central Arizona Water Conservation District, Phoenix, AZ
Governor, Gila River Indian Community, Sacaton, AZ (Attn: John Hestand)
Chairman, San Carlos Apache Tribe, San Carlos, AZ (Attn: Ned Anderson)
Robin Silver, Center for Biological Diversity, Phoenix, AZ
Director, Arizona Game and Fish Dept., Phoenix, AZ
Director, New Mexico Department of Game and Fish, Santa Fe, NM
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    David Propst, New Mexico Dept. of Game and Fish, Santa Fe, NM
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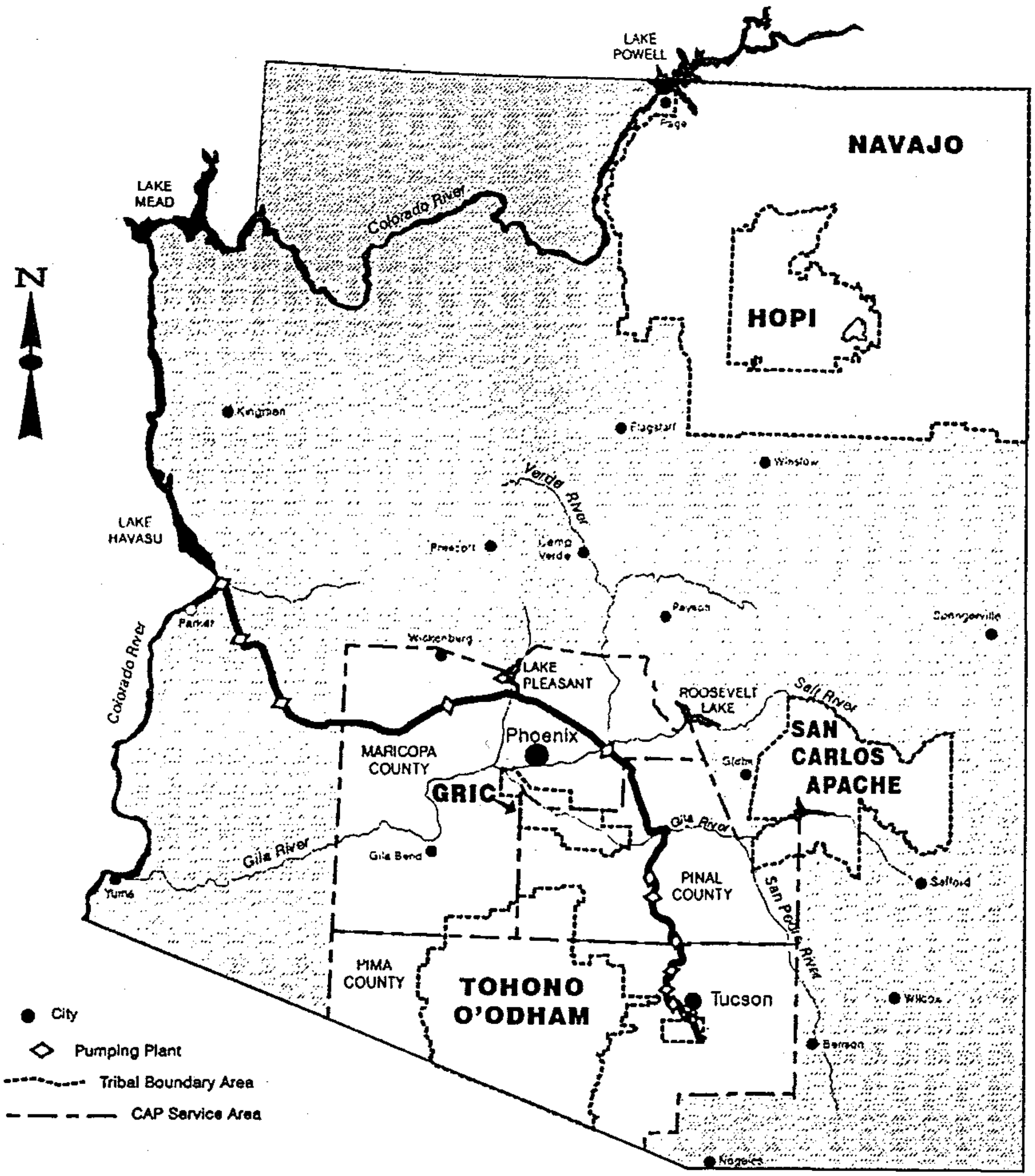
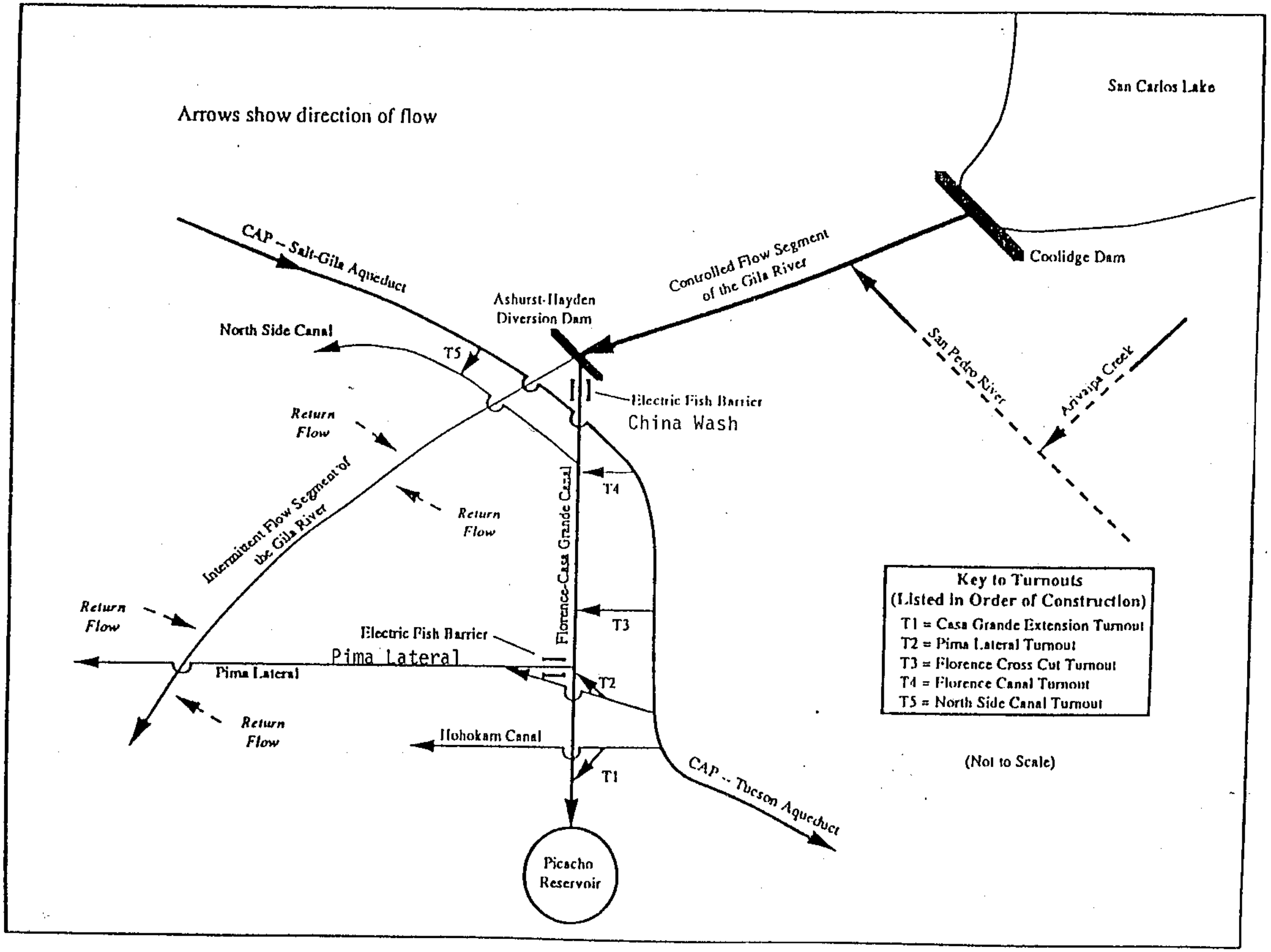
FIGURE 1. Route of Central Arizona Project



CENTRAL ARIZONA PROJECT

Prepared for: U.S. Department of the Interior, Bureau of Reclamation — June 2000	TAKEN FROM **CAP Allocation Draft EIS** **Central Arizona Project**	**Figure 1**

FIGURE 2. Diagram of Pima Lateral Feeder Canal Turnout and Adjacent Area



Arrows show direction of flow
San Carlos Lake
Coolidge Dam
Controlled Flow Segment of the Gila River
San Pedro River
Aravaipa Creek
CAP – Salt-Gila Aqueduct
Ashurst-Hayden Diversion Dam
North Side Canal
T5
Electric Fish Barrier
China Wash
Return Flow
Return Flow
Intermittent Flow Segment of the Gila River
Florence-Casa Grande Canal
T4
T3
T2
T1
Return Flow
Electric Fish Barrier
Pima Lateral
Pima Lateral
Return Flow
Hohokam Canal
CAP -- Tucson Aqueduct
Picacho Reservoir
Key to Turnouts
(Listed in Order of Construction)
T1 = Casa Grande Extension Turnout
T2 = Pima Lateral Turnout
T3 = Florence Cross Cut Turnout
T4 = Florence Canal Turnout
T5 = North Side Canal Turnout
(Not to Scale)

FIGURE 3. Introduction methods of nonnative fishes in the United States

TABLE 1. Responsible Parties for Actions Related to CAP[1]

ACTION	FEDERAL	STATE	TRIBAL	PRIVATE
Ownership of aqueduct and facilities	Reclamation			
Construction of aqueduct and facilities	Reclamation			
Construction of CAP water storage facilities (not including storage of water taken by contractors/subcontractors)	Reclamation			
Operation and maintenance of aqueduct and facilities	Reclamation (pre-1993)	CAWCD (post-1993)		
Allocation and reallocation of CAP water	Reclamation			
Delivery of water to CAWCD (contract holder)	Reclamation			
Delivery of water to Tribes (contract holder)	Reclamation			
Delivery of water to subcontractors		CAWCD		
CAP water “exchanges”	Reclamation			
Construction of new aqueduct features and facilities, including water turnout facilities	Reclamation	CAWCD		
Conducting and maintaining cultural and environmental mitigation features/actions	Reclamation			
Stocking of fish and wildlife into CAP waters (such as Town Lake)		AGFD		
Regulation of fishing, stocking of fish/wildlife/plants, aquaculture in CAP aqueduct	Reclamation	CAWCD AGFD ADA		
Regulation of fishing, stocking of fish/wildlife/plants, aquaculture in CAP waters		AGFD ADA		
Use of CAP water			X	X

TABLE 1. Responsible Parties for Actions Related to CAP[1]

ACTION	FEDERAL	STATE	TRIBAL	PRIVATE
Construction, operation, and maintenance of water use facilities				X
Construction, operation, and maintenance of water use facilities on Tribal lands	Reclamation		X	
Use of effluent and other water made available by CAP water			X	X
Recharge facilities and operation		X	X	X
Development based on CAP water			X	X

[1] The party which has final authority or approval rights to the action. This may not be the entity which actually does the action. The focus here is which types of ownership have discretionary actions that are subject to Endangered Species Act review.

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

TABLE 2. Central Arizona Project 1999 Water Deliveries by Turnout
(taken from the January 3, 2001 Reclamation biological assessment)

CENTRAL ARIZONA PROJECT
1999 WATER DELIVERIES BY TURNOUT
(acre-feet)

Table 2

Taken from Jan. 3, 2001 Reclamation Biological Assessment

LITTLE HARQ.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
V.F. Investments	360	0	323	152	0	478	0	238	430	0	0	0	1,981
Vidler Water Co	0	14	0	0	2	113	51	31	290	336	315	0	1,152
Harquahala Valley	2,000	2,230	2,897	6,243	9,091	7,274	7,003	8,695	3,441	1,969	998	1,509	53,350
ARR Farms Partn	0	0	0	0	0	0	0	0	0	0	0	255	255
Calron Cotton Ptn	0	0	0	13	1,134	984	828	541	0	0	0	0	3,500
Farmco Partnership	0	0	0	289	341	1,124	1,413	1,233	0	0	0	0	4,400
Gladden Farms II	334	241	485	25	0	0	0	0	0	0	0	0	1,085
M&M Farms	0	0	0	157	280	252	179	261	14	0	0	0	1,143
Rylan Farms Ptn	0	0	88	383	514	510	574	275	28	0	66	55	2,493
Triple W Farms Ptn	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood Brothers	0	0	0	63	28	0	21	250	0	21	105	80	568
Tonopah/Goodyear	0	0	0	0	563	1,256	1,943	1,946	546	647	345	211	7,457
Tonopah ID	125	264	912	1,333	1,407	1,218	0	0	0	0	0	0	5,259
SGMT 2 TOTAL	2,819	2,749	4,705	8,658	13,360	13,209	12,012	13,470	4,749	2,973	1,829	2,110	82,643

HASSAYAMPA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MWD	0	0	1,766	2,944	2,944	2,993	2,961	2,976	1,789	1,627	0	0	20,000
Anthem Phoenix	69	57	115	127	173	197	153	224	190	194	166	186	1,851
Town of Goodyear	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Glendale	1,458	1,173	1,523	1,276	1,579	2,035	1,975	2,363	1,383	1,586	969	749	18,069
City of Peoria	151	175	229	221	242	244	247	262	261	261	246	241	2,780
CCC Mines, L.L.C.	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Phoenix	2,318	33	2,623	7,234	8,485	9,948	9,736	10,230	8,822	9,359	7,660	7,762	84,210
Mazatzal Tree Farm	1	1	1	1	2	2	3	3	3	2	2	1	22
Cave Creek Water	65	62	76	93	89	121	115	116	0	83	93	97	1,010
Maricopa County	28	19	35	36	81	103	68	77	61	56	27	20	611
Az. Wholesale Grs	4	3	3	4	2	1	0	2	4	4	3	2	32
Ancala CC	22	20	26	28	56	58	43	55	38	64	29	27	466
City of Scottsdale	1,259	1,532	1,643	2,051	3,362	4,014	3,704	4,140	3,317	4,052	3,311	2,465	34,850
Carefree Water Co	0	18	41	41	42	38	23	27	39	62	33	26	390
Rock Resources	0	0	0	1	0	0	0	1	0	0	0	0	2
Scottsdale Garden	0	0	0	0	0	1	0	0	0	1	0	0	2
Scottsdl (Westworld)	0	0	0	0	0	0	116	97	82	47	38	23	403
Chaparral City WC	369	331	390	380	482	480	364	466	382	488	382	307	4,821
Az St Land/ADOT	75	11	547	270	79	49	25	32	0	6	7	7	1,108
SRP - ASL/ADOT	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Avondale	0	0	0	0	0	0	4,657	0	0	600	1,389	25	6,671
SRP - AWBA	0	0	0	0	6,281	5,327	2,292	2,234	2,299	1,788	1,863	0	22,084

TABLE 2. page 2

SRP - Cnyn Frst Vlg	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Chandler	0	60	89	730	9,976	325	274	5,050	349	150	151	554	17,708
SRP - Del Webb	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Gilbert	0	0	0	0	0	150	198	199	180	120	0	60	907
SRP - Glendale	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - GRUSP/WB	3,822	4,706	5,125	3,496	4,449	4,689	5,755	7,001	6,995	7,359	3,618	4,146	61,161
SRP - Mesa	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Peoria	0	0	0	14,920	4,985	0	0	0	0	0	0	0	19,905
SRP - Phoenix	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Raven	0	0	0	0	0	0	0	0	0	0	0	0	0
SRP - Rec Ctr	0	0	0	0	0	0	0	0	0	0	49	49	98
SRP - Rio Salado	0	0	1,000	995	983	999	996	1,000	0	0	0	0	5,973
SRP - Rio Verde	0	0	0	0	0	0	0	0	0	0	151	0	151
SRP - RWCD/Mesa	0	0	0	2,275	1,967	4,940	1,348	695	0	0	0	0	11,225
SRP - Scottsdale	0	0	4,993	0	0	0	0	0	0	0	0	0	4,993
SRP - Surplus	0	0	9,417	12,010	14,993	16,629	1,362	5,613	0	0	0	0	60,024
SRP - Tempe	262	301	299	398	1,097	400	449	451	349	200	151	252	4,609
SRP - V&P Nurseries	0	0	0	0	0	0	0	0	0	0	0	50	50
SGMT 3 TOTAL	9,903	8,502	29,941	49,531	62,349	53,743	36,864	43,314	26,543	28,109	20,338	17,049	386,186

SALT GILA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
RWCD	5,374	3,463	5,340	3,051	1,853	7,189	1,706	6,144	3,737	2,705	131	582	41,275
Mesa Family Golf	0	0	0	4	0	4	0	0	0	0	67	0	75
Springfield Golf Res	0	0	0	0	0	0	0	0	5	0	0	0	5
Springfield Lakes	0	0	0	0	0	0	0	0	0	0	0	63	63
San Carlos Apache	0	2,500	2,500	2,500	6,500	0	0	0	0	0	0	0	14,000
Red Mt. Ranch CC	49	34	52	49	82	75	59	64	40	79	66	34	683
Red Mt. Rnch Ownrs	1	0	1	0	1	2	1	1	1	1	1	2	12
Apache Junction WC	3	2	3	2	5	2,895	5	3	3	5	4	1,003	3,933
City of Mesa	1,900	1,729	2,501	1,764	2,269	2,141	2,609	2,522	2,387	3,244	3,202	2,712	28,980
City of Chandler	291	235	30	24	154	700	209	263	165	232	305	185	2,793
AWC-Apache Jct	330	279	364	363	580	576	435	507	430	678	422	337	5,301
Town of Gilbert	102	99	121	124	138	207	193	212	183	176	166	90	1,811
Sonoran Land Grp	32	30	43	43	76	143	16	61	42	65	39	28	618
Viewpoint Golf	19	16	25	26	48	49	41	103	77	28	15	9	456
Queen Creek (AG)	1,943	2,296	5,564	4,585	6,421	6,578	4,852	5,193	2,118	1,380	1,202	1,396	43,528
H20, Inc.	0	0	0	0	5	4	4	4	3	1	2	2	25
Queen Creek (M&I)	6	9	44	32	67	84	79	72	57	140	95	41	726
San Tan ID	27	1	355	525	411	612	792	666	444	595	432	73	4,933
Chandler Heights	84	77	72	42	178	257	183	150	107	150	127	95	1,522
New Magma IDD	2,034	2,778	7,814	8,377	11,966	9,830	13,162	15,311	8,129	4,338	3,177	2,297	89,213
Santan Mountain	13	18	16	76	140	130	117	53	14	53	0	0	630
Oasis Golf Resort	0	0	0	0	0	0	0	0	0	8	29	0	37
Pinal County (XS)	0	0	0	0	0	0	0	0	0	0	0	8	8
James M. Jones	0	0	0	0	0	0	0	63	0	0	0	0	63
San Carlos IDD	0	0	1,356	840	1,140	2,334	3,550	1,208	1,833	0	0	41	12,302
Pinal Cnty/Pic Res	0	240	902	217	892	97	563	66	0	0	0	492	3,469
San Carlos Project	0	0	0	0	887	18,776	9,451	4,282	580	0	0	0	33,976
Gila River Indians	0	0	0	2,974	2,870	0	7,684	1,243	135	753	0	817	16,476

Hohokam-Kleck	346	149	326	346	296	763	1,038	1,161	291	0	0	16	4,732
Hohokam-CG	1,928	3,280	6,467	4,544	3,784	9,025	8,371	8,610	3,003	2,176	431	2,287	53,906
City of Eloy/Aug Auth	0	0	0	0	1,500	0	0	0	0	0	0	0	1,500
Town of Florence/AA	0	0	0	0	2,048	0	0	0	0	0	0	0	2,048
Mollick, Pete	0	0	0	0	0	0	0	0	0	0	0	0	0
Maricopa Stanfield	5,546	7,405	18,052	13,476	17,590	26,602	19,171	24,343	7,066	5,008	2,091	4,406	150,756
CAIDD-SRO	494	1,142	3,634	2,643	3,050	3,948	4,611	5,481	1,367	446	207	631	27,654
Ak-Chin Indains	3,074	3,502	9,396	7,271	10,185	8,732	7,688	8,166	3,903	2,271	2,847	2,174	69,209
Pnal Cnty Aug Auth	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Eloy	32	14	31	36	74	26	109	56	16	23	22	10	449
FNF Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunbelt Ornamental	1	1	2	2	3	4	3	3	3	4	2	1	29
Brownmiller, Jeff	0	0	0	0	0	0	0	0	0	0	0	0	0
AWC-Casa Grnd	11	7	6	14	0	0	0	0	0	0	0	0	38
SGMT 4 TOTAL	23,640	29,306	65,017	53,950	75,213	101,783	86,702	86,011	36,139	24,559	15,082	19,832	617,234

BRADY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CAIDD-CMan	1,886	3,746	11,433	9,591	8,580	11,439	11,963	14,137	3,624	1,655	995	765	79,814
City of Eloy	0	0	6	4	4	5	3	5	3	2	0	0	32
Pnal Cnty Aug Auth	0	0	0	0	0	0	0	0	0	0	0	0	0
Picacho School	0	0	3	0	0	6	0	5	0	0	0	0	14
SGMT 5 TOTAL	1,886	3,746	11,442	9,595	8,584	11,450	11,966	14,147	3,627	1,657	995	765	79,860

PICACHO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CAIDD-SMan	550	594	5,106	4,953	3,499	4,307	4,285	4,436	751	726	992	740	30,939
SGMT 6 TOTAL	550	594	5,106	4,953	3,499	4,307	4,285	4,436	751	726	992	740	30,939

RED ROCK	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
B.K.W./Tucson	528	454	1,005	1,547	665	680	784	1,206	236	240	186	97	7,628
AVRP/Metro	410	238	693	503	376	0	0	0	0	0	0	0	2,220
AVRP/AWBA	0	0	0	0	407	712	408	460	276	540	527	231	3,561
Kai Farms/Metro	0	0	216	899	885	0	0	0	0	0	0	0	2,000
Kai/Spanish Trail	0	0	0	0	277	1,047	465	1,467	1,195	277	76	90	4,894
Town of Marana	0	0	0	0	0	0	0	0	0	0	0	47	47
CMID/Spanish Trail	475	75	1,545	1,827	463	1,364	721	1,088	5	0	152	36	7,751
Kai/Oro Valley	931	505	564	0	0	0	0	0	0	0	0	0	2,000
SGMT 7 TOTAL	2,344	1,272	4,023	4,776	3,073	3,803	2,378	4,221	1,712	1,057	941	501	30,101

SANDARIO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CAVSARP/AWBA	678	633	811	727	620	785	650	585	657	515	500	204	7,365
CAVSARP/Tucson	677	632	810	726	620	784	649	584	656	514	500	204	7,356
SGMT 9 TOTAL	1,355	1,265	1,621	1,453	1,240	1,569	1,299	1,169	1,313	1,029	1,000	408	14,721

SNYDER HILL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
City of Tucson	13	0	0	43	8	68	0	0	0	0	18	12	162
SGMT 12 TOTAL	13	0	0	43	8	68	0	0	0	0	18	12	162

BLACK MT.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Arroyos	0	0	0	0	0	0	0	0	0	0	0	0	0
Pima Mine (AWBA)	1,248	1,145	129	8	0	1,198	849	1,297	1,241	1,277	1,287	789	10,468
Pima Mine (GVWC)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pima Mine (TUC)	0	0	0	0	0	0	0	0	0	0	0	0	0
CAGRD (PMR)	0	0	12	0	0	0	0	0	0	0	0	0	12
SGMT 13 TOTAL	1,248	1,145	141	8	0	1,198	849	1,297	1,241	1,277	1,287	789	10,480

PERMITS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Temp. Water Use	53	48	122	42	42	40	17	19	15	27	41	78	544
VARIOUS	53	48	122	42	42	40	17	19	15	27	41	78	544

TOTAL	43,811	48,627	122,118	133,009	167,368	191,170	156,372	168,084	76,090	61,414	42,523	42,284	1,252,870

Table 2 continued

Table 2 continued

Table 2 continued

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

Past actions are any actions in the action area that occurred prior to the date of this consultation.

Interrelated actions are those non-Federal actions that are part of a larger action and depend upon that action for their justification. Interdependent actions are those non-Federal actions that have no independent utility apart from the action under consultation.

Proposed action is the Federal action under consultation.

Future non-Federal actions are any actions in the action area that are reasonably foreseeable to occur.

Direct effects are those effects that are a direct result of some action. The term "direct effects" in a section 7 context normally refers to those of the proposed Federal action. However, other related action (past, interrelated, interdependent, future non-Federal) may all have effects that are a direct result of those actions.

Indirect effects are those that are caused by some action, but are later in time. The term "indirect effects" in a section 7 context normally refers to those of the proposed Federal action. However, other related actions (past, interrelated, interdependent, future non-Federal) may all have indirect effects. Indirect effects of the proposed Federal action usually refer to those which result from that specific action and do not have an intervening State, Tribal or private action. However, an interdependent and interrelated State, Tribal, or private action may occur as an indirect effect of the Federal action.

Cumulative effects result from future non-Federal actions that are reasonably certain to occur.

TABLE 4. Transfer of aquatic species via interbasin water transfers: Selected cases.

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

TABLE 4. Transfer of aquatic species via interbasin water transfers: Selected cases.

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

TABLE 4. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Fox-Wisconsin Canal	Mississippi River to Great Lakes	shortnose gar (*Lepisosteus platostomus*) bowfin (*Amia calva*) river darter (*Percina shumardi*) sauger (*Stizostedion canadense*)	USBR 1990 Becker 1983 Fuller *et al.* 1999
Coachella Canal	Colorado River to Coachella Valley (southern CA)	striped bass (*Morone saxatilis*)	Swift et al. 1993
All-American Canal	Colorado River to Imperial Valley (southern CA)	Rio Grande leopard frog (*Rana berlandieri*)	J. Rorabaugh, USFWS, pers. comm. 1998
Los Angeles Aqueduct	Owens River to Santa Clara River (southern CA)	Owens sucker (*Catostomus fumeiventris*)	Moyle 1976
California Aqueduct	Central and northern inland California drainages to southern California coastal drainages	Sacramento squawfish (*Ptychocheilus grandis*), striped bass, interior prickly sculpin (*Cottus asper*), inland silverside (*Menidia beryllina*), white catfish (*Ameirus catus*), tule perch (*Hysterocarpus traski*), bigscale logperch (*Percina macrolepida*), chameleon goby (*Tridentiger trigonocephalus*), blackfish (*Orthodon microlepidus*) Asian clam (*Corbicula fluminea)*	Swift *et al.* 1993 Claudi and Leach 2000
	San Francisco Bay to San Luis Reservoir and O'Neill forebay (S. CA)	starry flounder (*Platichthys stellatus*)	Moyle 1976
Colorado River Aqueduct	Colorado River to San Diego coastal drainages	goldfish (*Carassius auratus*) common carp (*Cyprinus carpio*)	Swift *et al.* 1993
Central Arizona Project	Colorado River to Gila River (AZ)	striped bass	Arizona Game and Fish Department unpublished data

TABLE 4. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Morenci Diversion	Black River to Eagle Creek (AZ)	smallmouth bass (*Micropterus dolomieu*)	Marsh *et al*. 1990
Tenn-Tom Waterway	Tombigbee River (Mobile Bay) to Tennessee River (Mississippi drainage) (TN/AL)	blacktail shiner (*Cyprinella venusta stigmatura*) weed shiner (*Notropis texanus*) Atlantic needlefish (*Strongylura marina*)	Etnier and Starnes 1993
	Tennessee River to Tombigbee River	yellow bass (*Morone mississippiensis*) yellow perch (*Perca flavescens*)	Boschung, 1992 (as cited in Mettee et al. 1996) Mettee *et al*. 1996
unnamed diversion	Tallaposa River to Conecuh River (AL)	blacktip shiner (*Notropis atrapiculus*)	Lee *et al*. 1980
SE Florida Water Management District's Canal L31W	southeastern Florida to Everglades National Park	oscar (*Astronotus ocellatus*)	Courtenay 1989
Tamiami Canal	southeastern Florida to Everglades area	walking catfish (*Clarius batrachus*)	Claudi and Leach 2000
Ely Ouse to Essex Transfer	Great Ouse to River Stour, (Great Britain)	diatom (*Stephanodiscus* sp.) zander (*Stizostedion lucioperca*)	Guiver 1976 (as cited in Meador 1992)
Severn-Thames Transfer	Thames River to River Severn (Llandegfedd Reservoir) (Great Britain)	roach (*Rutilis rutilus*) dace (*Leuciscus leuciscus*)	Mann 1988, Solomon 1975
Tajo-Segura Transfer	Tajo to Segura River (Spain)	gudgeon (*Gobio gobio*)	Garcia de Jalon 1987
numerous canals in Russia and Europe	Aral, Black and Caspian drainages to Atlantic Ocean and North and Baltic drainages	zebra mussel	Garton et al. 1993

TABLE 4. Transfer of aquatic species via interbasin water transfers: Selected cases.

Project	Connected Basins	Species Transferred	References
Orange River Project (Orange-Fish Tunnel)	Orange River to Great Fish River and Sundays River (South Africa)	sharptooth catfish (*Clarias gariepinus*) smallmouth yellowfish (*Barbus aeneus*) rock barbel (*Geophyroglans sclateri*) Orange R. mudfish (*Labeo capensis*)	Macdonald *et al*. 1986, Laurenson and Hocutt 1986, Petitjean and Davies 1988
Panama Canal	Atlantic Ocean to Pacific Ocean	Atlantic pipefish (*Oostethus brachyurus lineatus*)	Chickering 1930
	Pacific Ocean to Atlantic Ocean	goby (*Lophogobius cristulatus*)	Rubinoff and Rubinoff 1968
	Caribbean Ocean to Gatun Lake	snook (*Centropomus* sp.) tarpon (*Megalops atlanticus*)	Rubinoff 1970
Suez Canal	Red Sea to Mediterranean Sea	algae - 2 species, plants - 12 species, invertebrates - 72 species, fish - 27 species	Por 1978
	Mediterranean Sea to Red Sea	algae - 1 species, invertebrates - 44 species, fish 15 species	Por 1978

TABLE 5. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal. (bold face **common name** indicates the species has been found in the Tucson reach of CAP)

SPECIES	CAP AQUEDUCT Mueller (1989)	CAP AQUEDUCT Clarkson (1998) Clarkson (1999) Clarkson (2001)	SRP and F-CG Canals Marsh and Minckley (1982), Matter (1991), Wright and Sorenson (1995), Clarkson (1998) and Girmendonk and Young (1997), Marsh 1999, Bettaso 2000
Threadfin shad (*Dorosoma petenense)*	X	X	X
Rainbow trout (*Oncorhynchus mykiss*)			X
Brook trout (*Salvelinus fontinalis*)			X
Common carp (*Cyprinus carpio*)	X	X	X
Grass carp (*Ctenopharyngodon idella*)		X	X
Grass carp X bighead carp hybrid (*C. idella X Aristichthys nobilis*)			X
Goldfish (*Carassius auratus*)	X	X	X
Red shiner (*Cyprinella lutrensis*)	X	X	X
Beautiful shiner (*Cyprinella formosa*)			X
Fathead minnow (*Pimephales promelas*)			X
Longfin dace[1] (*Agosia chrysogaster*)			X
Roundtail chub[1] (*Gila robusta*)			X
Bigmouth buffalo (*Ictiobus cyprinellus*)			X
Desert sucker[1] (*Catostomus [Pantosteus] clarki*)	X		X
Sonora sucker[1] (*Catostomus insignis*)	X		X
Razorback sucker[1] (*Xyrauchen texanus*)	X		
Flathead catfish (*Pylodictus olivaris*)	X		X
Channel catfish (*Ictalurus punctatus*)	X	X	X
Yellow bullhead (*Ameiurus natalis*)	X	X	X
Black bullhead (*Ameiurus melas*)		X	X
Mosquitofish (*Gambusia affinis*)	X		X
Sailfin molly (*Poecilia latipinna*)			X
Shortfin molly (*Poecilia mexicana*)			X
Guppy (*Poecilia reticulata*)			X

TABLE 5. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal. (bold face **common name** indicates the species has been found in the Tucson reach of CAP)

SPECIES	CAP AQUEDUCT Mueller (1989)	CAP AQUEDUCT Clarkson (1998) Clarkson (1999) Clarkson (2001)	SRP and F-CG Canals Marsh and Minckley (1982), Matter (1991), Wright and Sorenson (1995), Clarkson (1998) and Girmendonk and Young (1997), Marsh 1999, Bettaso 2000
Swordtail (*Xiphophorus variatus*)			X
Striped bass (*Morone saxatilis*)	X	X	
White bass (*Morone chrysops*)		X	
Yellow bass (*Morone mississippiensis*)			X
Largemouth bass (*Micropterus salmoides*)	X	X	X
Smallmouth bass (*Micropterus dolomieu*)			X
Redear sunfish (*Lepomis microlophus*)	X	X	X
Bluegill (*Lepomis macrochirus*)	X	X	X
Green sunfish (*Lepomis cyanellus*)	X	X	X
Black crappie (*Pomoxis nigromaculatus*)	X		X
Walleye (*Stizostedion vitreum*)			X
Rio Grande cichlid (*Cichlasoma cyanogutattum*)			X
firemouth cichlid (*Cichlasoma meeki*)			X
convict cichlid (*Cichlasoma nigrofasciatum*)			X
Oscar (*Astronotus ocellatus*)			X
Blue tilapia (*Tilapia aurea*)			X
Mozambique tilapia (*Tilapia mossambica*)			X
Redbelly tilapia (*Tilapia zilli*)			X
Snail[2] (*Helisoma [=Planorbella] campanulata*)	X	ND	ND
Asian clam[2] (*Corbicula fluminea*)	X	ND	X
Red swamp crayfish (*Procambarus clarki*)		ND	X
freshwater sponge (*Porifera*)	X	ND	
chara[1] (*Chara* sp.)	X	ND	
spiny naid[1] (*Najas* sp.)	X	ND	
curlyleaf pondweed (*Potamogeton crispus*)	X	ND	X
sago pondweed[1] (*Potamogeton pectinatous*)	X	ND	X
Horned pondweed[1] (*Zannichellia palustris*)		ND	X
water-milfoil (*Myriophyllum brasiliense*)		ND	X

TABLE 5. Species collected in Central Arizona Project (CAP) Aqueduct, Salt River Project (SRP) Canals, and the Florence-Casa Grande (F-CG) Canal. (bold face **common name** indicates the species has been found in the Tucson reach of CAP)

SPECIES	CAP AQUEDUCT Mueller (1989)	CAP AQUEDUCT Clarkson (1998) Clarkson (1999) Clarkson (2001)	SRP and F-CG Canals Marsh and Minckley (1982), Matter (1991), Wright and Sorenson (1995), Clarkson (1998) and Girmendonk and Young (1997), Marsh 1999, Bettaso 2000
Eurasian water-milfoil (*Myriophyllum spicatum*)		ND	X
algae[1] (*Nostoc* sp.)		ND	X
algae[1] (*Cladophora* sp.)	X	ND	X

[1] native
[2] Mueller (1990) mentions snails and insects being present, but does not document species for invertebrates other than the three in this table. *Helisoma campanulata* is a nonnative, but there are native *Helisoma* and the identification may be erroneous.

APPENDIX 1. Scientific Names of Species in Text

Apache trout *Oncorhynchus apachae*

Asian clam *Corbicula fluminea*

Bald eagle *Haliaeetus leucocephalus*

Bullfrog *Rana catesbeiana*

Chirichahua leopard frog *Rana chiricahuensis*

Colorado squawfish (Pikeminnow) *Ptychocheilus lucius*

Common carp *Cyprinus carpio*

Cottonwood *Populus* spp.

Desert pupfish *Cyprinodon macularius*

Fathead minnow *Pimephales promelas*

Flathead catfish *Pylodictis olivaris*

Giant salvinia *Salvinia molesta*

Gila topminnow *Poeciliopsis occidentalis occidentalis*

Gila trout *Oncorhynchus gilae*

Juniper *Juniperus* spp.

Loach minnow *Tiaroga (Rhinichthys*) *cobitis*

Mosquitofish *Gambusia affinis*

Pinyon pine *Pinus* spp.

Ponderosa pine *Pinus ponderosa*

Rainbow trout *Oncorhynchus mykiss*

Razorback sucker *Xyrauchen texanus*

Rio Grande leopard frog *Rana berlandieri*

Ruffe *Gynocephalus cernus*

Salt cedar *Tamarix* spp.
Spikedace *Meda fulgida*

Striped bass *Morone saxatilis*

Sycamore (Arizona) *Platanus wrightii*

Water cress *Rorippa nasturtium aquaticum*

White bass *Morone chrysops*

Willow *Salix* spp.

BACKGROUND INFORMATION ON THE CENTRAL ARIZONA PROJECT

AND

NONNATIVE AQUATIC SPECIES

IN THE

GILA RIVER BASIN

(excluding the Santa Cruz River Subbasin)

April 2001

U.S. Fish and Wildlife Service

Phoenix, Arizona

TABLE OF CONTENTS

INTRODUCTION

The purpose of this document is to provide additional information in support of the April 17, 2001 biological opinion to the Bureau of Reclamation on the effects of transportation and delivery of water through Central Arizona Project (CAP) to listed species in the Gila River basin (excluding the Santa Cruz River subbasin) through the introduction and spread of nonnative aquatic species (USFWS 2001a). The biological opinion was issued in response to a January 3, 2001 request from the Reclamation for reinitiation of consultation on an April 15, 1994 (transmitted April 20, 1994) biological opinion on that subject (USFWS 1994a). The species of concern are the endangered Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, and Gila trout, and the threatened spikedace, loach minnow, bald eagle, and Apache trout.

The information contained in this document was summarized or incorporated by reference in the April 17, 2001 biological opinion. The Fish and Wildlife Service identification number for the consultation is 2-21-90-F-119a

Acronyms and abbreviations used in this document are defined in Appendix 1. Scientific names for species referred to by common names in this document are found in Appendix 2.

This document is based on the 1994 biological opinion, information from which is incorporated here by reference (USFWS 1994a); information used in the preparation of the 1994 biological opinion; the January 3, 2001 biological assessment (USBR 2001); March 16 and 30, 2001 Reclamation memoranda amending the biological assessment; April 6-13, 2001 comments on the draft biological opinion from Reclamation, Central Arizona Water Conservation District (CAWCD), Gila River Indian Community (GRIC), and the Center for Biological Diversity; telephone conversations; meetings; data in our files; and other sources of information. Literature cited in this document, along with those cited in the biological opinion, are cited in support of data and concepts in the document and opinion. They do not represent a complete bibliography of all references available on the species of concern, the effects of the proposed action, or on other subjects considered in this document and the biological opinion.

CONSULTATION HISTORY

A summary of the following consultation history is included in the April 17, 2001 biological opinion.

PAST CONSULTATIONS ON CAP

From 1983 to date, there have been 45 informal consultation and 17 formal consultations with biological opinions issued to Reclamation on effects of various aspects of CAP to 13 listed species, 6 of which are fishes (Table 1, Appendix 3).

Table 1. Section 7 Biological Opinions on the Central Arizona Project

Project	Date of Opinion	Species	Finding
Central Arizona Water Control Study - Plan 6[1]	March 8, 1983 amended April 7, 1983	bald eagle Yuma clapper rail Gila topminnow peregrine falcon	jeopardy nonjeopardy nonjeopardy nonjeopardy
Central Arizona Water Control Study, New Waddell Element of Plan 6[1]	Nov. 15, 1984 amended July 2, 1997	bald eagle	jeopardy
Ft. McDowell Indian Reservation Rehabilitation and Betterment Irrigation System	March 21, 1985	bald eagle	jeopardy
Central Arizona Water Control Study, Cliff Dam Element of Plan 6[1]	August 15, 1985	bald eagle	jeopardy
Tucson Aqueduct Phase B (CAP)	June 27, 1986	Tumamoc globeberry	jeopardy
Upper Gila Water Supply Study (Hooker/ Connor Dam)	draft March 9, 1987	spikedace loach minnow bald eagle	jeopardy nonjeopardy nonjeopardy
Central Arizona Water Control Study, Cliff Dam Element of Plan 6	March 10, 1987	Arizona cliffrose	nonjeopardy

Table 1. Section 7 Biological Opinions on the Central Arizona Project

Project	Date of Opinion	Species	Finding
Southern Arizona Water Rights Settlement Act, Papago and San Xavier Indian Reservations, (SAWRSA) and Schuk Toak	Nov. 2, 1987	Tumamoc globeberry	nonjeopardy
Central Arizona Water Control Study, Roosevelt Dam Element of Plan 6	March 30, 1990	bald eagle	nonjeopardy
Upper Gila Water Supply Study and Verde River Diversions	May 30, 1990 amended March 18, 1994	spikedace	jeopardy and adverse modification of propose critical habitat
Federal Loan Application, Fort McDowell Indian Reservation	Feb. 28, 1992	bald eagle	jeopardy
Transportation and Delivery of CAP Water To the Gila River Basin in AZ and NM (excluding the Santa Cruz subbasin)[1]	April 20, 1994 amended June 22, 1995, May 6, 1998, July 15, 1998, Jan.13, 2000, and June 30, 2000	spikedace loach minnow Gila topminnow razorback sucker Colorado squawfish desert pupfish bald eagle	jeopardy/ adverse mod. of ch.[2] jeopardy/ adverse mod. of ch.[2] jeopardy jeopardy and adverse mod. nonjeopardy nonjeopardy nonjeopardy
Operation of Modified Roosevelt Dam	July 23, 1996 amended June 7, 1999	SW willow flycatcher	jeopardy
Tucson Aqueduct System Reliability Investigation (TASRI) - construction and filling of reservoir	Feb. 11, 1998	Pima pineapple cactus	jeopardy
Central Arizona Project Water Assignment — Cottonwood Water Works and Camp Verde Water System to City of Scottsdale	March 30, 1998 amended April 28, 1998	razorback sucker bald eagle SW willow flycatcher Arizona cliffrose	nonjeopardy nonjeopardy nonjeopardy nonjeopardy
San Xavier CAP-Link Pipeline	May 13, 1999 amended May 26, 1999	Pima pineapple cactus	nonjeopardy

Table 1. Section 7 Biological Opinions on the Central Arizona Project			
Project	Date of Opinion	Species	Finding
Tucson Aqueduct System Reliability Investigation (TASRI)/Transportation and delivery of CAP Water to the Santa Cruz River Subbasin and it's Potential to Introduce and Spread Nonnative Aquatic Species[1]	draft June 11, 1999	Gila topminnow	jeopardy

[1]Addressed the potential for CAP to introduce and spread nonnative aquatic species.

[2]Critical habitat for these two species was subsequently revoked and the opinion was amended to remove the adverse modification finding.

Of those opinions, five address the potential for CAP to introduce and spread nonnative aquatic species. Three of the five opinions concern effects of introduction and spread of nonnative fish to the prey base of the endangered (now threatened) bald eagle in the Verde, Salt, and Agua Fria Rivers (USFWS 1983, 1984, and 1985a). One of those three also concerns effects to a population of Gila topminnow from nonnative fish introductions via CAP into Lake Pleasant on the Agua Fria River, and concludes that the effects would not jeopardize the continued existence of Gila topminnow (USFWS 1983). The fourth opinion was that of April 1994, which is now being reconsidered under this reconsultation. That opinion addresses the effects to six listed fish and the bald eagle from introduction and spread of nonnative aquatic species via CAP in the Gila River basin (excluding the Santa Cruz River subbasin) in Arizona and New Mexico (USFWS 1994a). And, the fifth is a draft opinion concerning the potential for introduction and spread of nonnative aquatic species via CAP in the Santa Cruz River subbasin and the effects to Gila topminnow (USFWS 1999a).

APPLICANTS

There were no requests for applicant status during the 1991-94 formal consultation on this project, which ended in the April 15, 1994 biological opinion. On December 4, 2000, Reclamation granted applicant status in this consultation to the CAWCD. On December 15, 2000, Reclamation granted applicant status in this consultation to the GRIC. A meeting was held with the applicants on March 2, 2001. At that meeting, the transfer of the 1994 reasonable and prudent alternative into the project description, as conservation measures, was discussed. Proposed addition of conservation measures beyond those in the 1994 reasonable and prudent alternative were also discussed, along with the new information to which those measures were responsive. The additions were agreeable to the applicants. As requested by Reclamation, the Service sent the draft biological opinion directly to the applicants on April 3, 2001, concurrently with sending it to Reclamation. Comments were received from both applicants, through Reclamation, on April 9, with additional comments from CAWCD on April 13, 2001. Comments were incorporated in the biological opinion, as appropriate.

APRIL 15, 1994 BIOLOGICAL OPINION

The April 15, 1994 biological opinion on transportation and delivery of CAP water in the Gila River basin (excluding the Santa Cruz River subbasin) resulted from recognition by the Service in 1989 that section 7 analysis of the potential for CAP to affect listed species through introduction and spread of nonnative aquatic species had been done only on a piecemeal basis and only for a few points along the system. No section 7 consultation had considered the nonnative species issue for the CAP system in its entirety or the aggregative or cumulative aspects of the problem. This recognition was triggered by analysis of proposed construction and operation of the Pima Lateral turnout that would transfer CAP water into existing irrigation canal systems near the confluence of the Gila and Santa Cruz Rivers. Besides recognition of the need to look at the system as a whole, the Service also recognized that many changes had occurred that might alter the findings of the 1983-85 opinions on CAP that addressed introduction and spread of aquatic nonnatives. Changes included designation of spikedace, loach minnow, and desert pupfish as threatened or endangered, and consideration for listing of the razorback sucker. None of these species were addressed in the earlier opinions. Status of two previously listed fishes had also changed substantially since the earlier opinions, including reintroduction into the Verde and Salt Rivers of experimental nonessential populations of the Colorado squawfish, and losses of many reintroduced populations of Gila topminnow resulting in a significant shift in recovery approach for that species.

Informal Consultation for the 1994 Biological Opinion

Informal consultation began in 1986 on the possible impacts of construction of the Pima Lateral Feeder Canal connection between the CAP aqueduct and the Florence-Casa Grande Canal system. A listing of the important events, correspondence, and meetings is given in Appendix 4. In the beginning of informal consultation, the CAP throughout the Gila River basin was included in the scope of the analysis. In May 1991, following initiation of formal consultation, Reclamation and the Service agreed to separate consideration of the Santa Cruz River subbasin from the rest of the Gila River basin. This was because operational details for the Tucson portion of the CAP were not yet complete and information was lacking. Further consideration of the Santa Cruz River subbasin on nonnative issues was put on hold and informal consultation did not resume for the subbasin until 1994.

After initial informal consultation, little contact occurred during 1987-1988. In 1989 however, communications resumed and in January 29, 1990, the Service agreed to allow interim water deliveries through the CAP connection if an electric barrier was installed on the Pima Lateral Feeder Canal and a study and monitoring were conducted. In March 1990, Reclamation approached the Service about water deliveries through five additional turnouts in the same area. The Service agreed to allow interim water deliveries through those turnouts, without formal consultation, if an additional electric barrier was constructed on the Florence-Casa Grande Canal. The first electric barrier was placed in operation in April 1990 and the second in May 1990.

A Reclamation study of the potential for selected nonnative fish to move out of the CAP and into native fish habitats was issued in February 1991 (Matter 1991). The report concluded that the presence of CAP made it likely that a) striped and white bass would reach the Gila River above Ashurst-Hayden Dam and the San Pedro River and its tributaries, but would not likely reproduce, b) blue tilapia would reach the Gila River above Ashurst-Hayden Dam and the San Pedro River and its tributaries, and would likely reproduce, c) grass carp would reach the Gila River above Ashurst-Hayden, but not the San Pedro and would not likely reproduce in either, and d) rainbow smelt would not likely survive in the CAP aqueduct and therefore would not reach the Gila River above Ashurst-Hayden via CAP. This report formed the basis of the 1991 biological assessment that Reclamation used to arrive at their conclusion that the CAP might affect, but would be unlikely to adversely affect, bald eagle, spikedace, and loach minnow. However, because Reclamation was aware of substantially different concerns of the Service, they requested formal consultation despite that conclusion.

Formal Consultation for the 1994 Biological Opinion

Formal consultation for the 1994 biological opinion was initiated on February 12, 1991. A consultation team of biological experts on Gila River basin native fishes was convened by the Service on May 7, 1991 to review effects analyses and help generate ideas for potential reasonable and prudent alternatives and conservation recommendations. That team consisted of Dr. W.L. Minckley and Dr. Paul Marsh of Arizona State University, Dr. William Matter, of the University of Arizona, Dr. David Propst with the New Mexico Department of Game and Fish, Jerome Stefferud with the U.S, Forest Service, and Eric Swanson with Arizona Game and Fish Department. Reclamation and Service staff also participated in team discussions.

The Service had committed to producing a biological opinion within 90 days, rather than the statutorily delineated 135 days. On May 21, 1991, Reclamation granted the Service an extension until June 1. A draft biological opinion was sent to Reclamation on May 30, 1991 finding jeopardy to spikedace, loach minnow, and Gila topminnow but not to desert pupfish, Colorado squawfish, or bald eagle. It also found jeopardy to the proposed endangered razorback sucker and adverse modification to the proposed critical habitat of spikedace and loach minnow.

The draft biological opinion contained a list of potential mechanisms to be used to formulate a final reasonable and prudent alternative that would remove the jeopardy. From that list the Service hoped to, with assistance from Reclamation, formulate a reasonable and prudent alternative that was technically and economically feasible. The underlying concept was a 3-layered one, first to keep nonnative species out of the CAP aqueduct, then to keep those that got into the aqueduct from leaving it, and third to keep any that escaped from reaching native fish habitats.

Reclamation had substantial concerns about the draft biological opinion and did not agree that a jeopardy situation existed. Meetings to find a common ground were held throughout the summer and autumn of 1991 between Reclamation and Service staff and management. In October, Reclamation requested a formal extension of the consultation until December 31, 1991. In November 1991, Reclamation agreed to accept the Service's opinion that the CAP would result in jeopardy to the four fishes and to move forward on formulation of a reasonable and prudent alternative. An additional extension of the consultation was requested by Reclamation until February 28, 1992. By December, efforts to find a reasonable and prudent alternative that could feasibly keep nonnative species from getting into the CAP aqueduct had proved fruitless. The draft reasonable and prudent alternative then retreated to a 2-layer concept that concentrated on keeping the nonnatives from leaving the aqueduct and then out of the native fish habitats.

However, little progress was made in finding agreement on a reasonable and prudent alternative and in June 1992 Reclamation and the Service agreed to extend the consultation period until August 26, 1992. A meeting of Reclamation and Service management in June 1992 resulted in a relatively substantial shift in the focus of the reasonable and prudent alternative, away from a technical solution toward a more process-oriented solution. In August the two agencies agreed to extend consultation until September 25, 1992.

After extensive additional negotiations, the process-oriented approach led to a 1-layered approach that focused on keeping the nonnatives that arrived via CAP out of native fish habitats. To accommodate the threats that could not be removed with this approach, the reasonable and prudent alternative adopted the "recovery in-lieu of threat removal" concept, whereby actions to improve the status of the jeopardized species elsewhere were substituted for direct removal of a portion of the CAP-caused threats. The overall improvement in species status makes the unremoved threats less important. Reclamation and Service staff met frequently through May 1993 to refine this approach, which was adopted in a revised draft biological opinion that was reviewed by Reclamation and Service management in May 1993.

However, there were still substantial areas of disagreement between Reclamation and the Service on what constituted a viable and economically and technically feasible reasonable and prudent alternative that would remove the threat of jeopardy to the four listed species. In September 1993, Reclamation sought, and received, concurrence from the Service for additional interim water deliveries through the Pima Lateral and adjacent CAP turnouts. Although SCIP had unilaterally, and against the wishes of the Service, ceased operation on the Pima Lateral Feeder Canal electric barrier in May 1992, the China Wash electric barrier was still in operation. Throughout autumn 1993, Reclamation and Service staff continued to work on a reasonable and prudent alternative.

In October 1993, Regional Directors from Reclamation and the Service met to discuss the consultation. They agreed that the provisions of the current draft reasonable and prudent alternative, that called for transfer of funds to the Service, had the appearance of a "buyout." Staff were instructed to find a different method of accomplishing the nonnative management and recovery in-lieu of threat removal that these funds were intended to support. Concerns about the extent of Reclamation authority to engage in strictly biological recovery tasks, along with concerns about duplicating existing Service and State recovery programs, led to generation of a revised reasonable and prudent alternative that assigned to Reclamation specific recovery and nonnative management tasks oriented toward Reclamation's particular expertise and authority. That revised reasonable and prudent alternative was submitted to the Regional Directors in late December/early January 1993.

In February 1994, due to authority and expertise considerations and estimates of increased costs, the Service and Reclamation decided to revert to the earlier version of the reasonable and prudent alternative and retain the funding transfer. Following meetings to work out final wording, the final biological opinion was issued on April 15, 1994 and transmitted to Reclamation on April 20, 1994.

While negotiation was ongoing, on September 26, 1993 the Maricopa Audubon Society filed a notice of intent to pursue legal action because of what they believed to be violations of the Endangered Species Act due to the lack of completed section 7 consultation on the CAP and nonnative species issues. On January 20, 1994, Earthlaw also filed a notice of intent.

The 1994 biological opinion was amended five times. The changes made by those amendments are shown in Table 2.

The April 1994 biological opinion concluded that introduction and spread of nonnative aquatic species in the Gila River basin (excluding the Santa Cruz subbasin) through CAP would result in jeopardy to the Gila topminnow, loach minnow, spikedace, and razorback sucker and would adversely modify the critical habitats of the last three species. The critical habitats for loach minnow and spikedace were later placed under an injunction by the courts and then revoked (USFWS 1998a) and the findings for those critical habitats were removed by amendment of the biological opinion in May 1998 and restored by amendment in June 2000, following redesignation. The 1994 opinion also concluded that the proposed action would not jeopardize the survival of desert pupfish, Colorado squawfish, and bald eagle.

Table 2. Amendments to the April 1994 Biological Opinion on the Transportation and Delivery of Water by the Central Arizona Project in the Gila River Basin

Amend. No.	Amendment Date	Opinion element affected	Change
1	June 22, 1995	RPA item 2	10 month extension of initiation of monitoring to August 1, 1995, with interim monitoring program.
		RPA items 3 and 4	12 month extension of first funding transfers to June 30, 1995, with final transfer mechanism to be in place by Oct. 1994.
2	May 6, 1998	finding for critical habitat	Removal of findings for critical habitat for spikedace and loach minnow due to court set-aside.
		RPA item 1	26 month extension for Aravaipa Creek barrier completion to Dec. 31, 1999.
3	July 24, 1998	action agency	Adds the Corps of Engineers issuance of 404 permit for barriers under RPA 1, as action covered by biological opinion.
4	Jan. 13, 2000	RPA item 1	Additional 6 month extension for Aravaipa Creek barrier completion to June 30, 2000; 12 month extension for San Pedro River barrier completion to April 15, 2001.
5	June 30, 2000	finding for critical habitat	Restores findings for critical habitat for spikedace and loach minnow under March 2000 designation.
		RPA item 1	Additional 4 month extension for Aravaipa Creek barrier completion to Nov. 1, 2000; additional 15 month extension for San Pedro River barrier completion to July 1, 2002 with option for replacing one barrier with one on Hot Springs Canyon by July 1, 2004.
		RPA items 3 and 4	Reviews effects of funding delays and finds no effect to removal of jeopardy and adverse modification.

A reasonable and prudent alternative, with five primary elements, was given in the 1994 biological opinion to allow the proposed action to proceed without jeopardizing the four species or adversely modifying their critical habitats; including 1) physical barriers, 2) monitoring, 3) recovery in-lieu of threat removal, 4) management against nonnative species, and 5) information and education. Implementation of the 1994 biological opinion is ongoing and is more fully described in the biological assessment (USBR 2001).

On March 7, 1997, the Southwest Center for Biological Diversity filed suit, alleging that the 1994 biological opinion was inadequate because the reasonable and prudent alternative did not sufficiently remove jeopardy and adverse modification; Southwest Center for Biological Diversity v. Babbitt, Civ. No. 97-474-PHX-SMM (D.Ariz.). On July 14, 1997, CAWCD filed suit, alleging that the biological opinion was flawed because no jeopardy or adverse modification was created by CAP activities; Central Arizona Water Conservation Dist. v. Babbitt, Civ. No. 97-1470-PHX-SMM (D.Ariz.). These suits were consolidated on August 24, 1997.

On September 30, 1999, the district court upheld the Service's jeopardy conclusion in the 1994 biological opinion. In a September 22, 2000 order, the court upheld the reasonable and prudent alternative in the 1994 jeopardy biological opinion, but also held that subsequent amendments to the reasonable and prudent alternative were arbitrary and capricious.

Accordingly, Reclamation and the Service reentered formal consultation. This biological opinion is the direct result of that reconsultation. Reclamation has continued to implement the terms of the reasonable and prudent alternative during reconsultation.

2001 REINITIATED CONSULTATION

Informal Consultation

Informal consultation for this reinitiation on introduction and spread of nonnative aquatic species in the Gila River basin (excluding the Santa Cruz subbasin) began in October 2000. Discussions were held regarding what type and level of information was needed to reinitiate and how that information would be provided.

On November 3, 2000, Reclamation requested formal reinitiation of section 7 consultation, but provided no biological assessment or other information on changes to the project, water use, environmental baseline, or any other information that might change the analysis of effects of the project on listed species. On November 21, 2000, the Service requested the pertinent information be furnished prior to initiation of formal consultation. The Service also committed to complete formal consultation by April 17, 2001, if the necessary information was furnished and formal consultation successfully initiated by January 3, 2001, and presuming rapid review by Reclamation and the applicants.

Formal Consultation

A biological assessment was delivered to the Service and formal consultation was initiated on January 3, 2001. In addition to the seven species in the 1994 biological opinion, two additional listed fish and one proposed frog were considered. The additional fish were considered because of new information on the extent to which invading nonnative species can move into distant portions of the Gila River basin. The frog, which was proposed for listing in June 2000, is seriously affected by nonnative species, and was not considered in 1994 because it was not federally listed.

In the biological assessment, Reclamation included the 1994 reasonable and prudent alternative as a part of the proposed action. The reasonable and prudent alternative and other mitigative commitments made in the proposed action will be referred to in this biological opinion as *conservation measures*. The purpose of these conservation measures is to avoid the likelihood that transportation and delivery of CAP water in the Gila River basin will jeopardize the continued existence of any listed species or destroy or adversely modify any designated critical habitats.

Reclamation and the Service conducted a series of meetings in January through March, 2001 to work out details of the conservation measures and other pertinent portions of the biological opinion. New information on species status, environmental baseline, nonnative species and their effects, CAP water usage, delivery systems, the effectiveness of 1994 reasonable and prudent alternative measures and their implementation, and delays in implementation was considered. Also new Service policy that does not allow for waiver of overhead charges (such as was done in the 1994 reasonable and prudent alternative) was considered. The new information led to a conclusion that changes and improvements were needed to the 1994 reasonable and prudent alternative and its ongoing implementation, before its adoption as the project conservation measures, to ensure that no listed species would be jeopardized or its critical habitat adversely affected from CAP introduced or mediated nonnative aquatic species. Therefore, additional conservation measures were incorporated into the project description to increase the level of threat removal above that provided by the 1994 reasonable and prudent alternative. Following negotiation of final changes to the project description, Reclamation submitted an addendum to the biological assessment on March 16, 2001.

On March 30, 2001, Reclamation again amended the biological assessment to provide details overlooked in the March 16 addendum, and to provide for retroactive overhead charges by the Service on recovery and nonnative management funds transferred to the Service from Reclamation in December 2000. These funds were transferred under the terms of the 1994 biological opinion, which prohibited use of the funds for overhead of either the Service or Reclamation. However, new Service policy is in conflict with that opinion and provisions for use of some of those funds for Service overhead are necessary.

Reclamation staff reviewed informal drafts of the project description section for the biological opinion and the consultation history portion of this document. Comments on the draft project description were received by the Service on March 27 and were incorporated, as appropriate.

On March 27, 2001, the Service and Reclamation agreed to remove conferencing for the Chiricahua leopard frog from this consultation. Because the distribution of and threats to the frog are somewhat different than the eight fish considered, and because nonnative species are such a serious threat to the Chiricahua leopard frog, additional analysis of the effects of the project and the conservation measures on the frog are needed before decisions regarding project effects can be made. The removal of the frog from this consultation avoids delaying completion of the reinitiated consultation as mandated by the September 22, 2000 court order.

A draft of the biological opinion was delivered to Reclamation, for review, on April 3, 2001. At Reclamation's request, copies were sent by the Service to the applicants for their review. To comply with litigation related agreements the Service also sent a copy to the Center for Biological Diversity (formerly the Southwest Center for Biological Diversity). Comments from Reclamation, including applicant comments, were received by the Service on April 9, 2001. Comments from Southwest Center were received by e-mail, also on April 9, 2001. Additional comments were received from CAWCD on April 13, 2001.

Following incorporation of comments, a final biological opinion was prepared and delivered to Reclamation on April 17, 2001. This background document accompanied the final biological opinion. At Reclamation's request, copies were sent by the Service to the applicants and to several other interested parties. A copy was also sent to the Center for Biological Diversity.

PROJECT DESCRIPTION AND CONSERVATION MEASURES

The description of the proposed action in the biological opinion is relatively complete, including a full description of the conservation measures proposed. Conservation measures are actions proposed by Reclamation to remove or compensate for threats to listed species posed by the introduction and spread of nonnative aquatic species via CAP. A map of the project location is found in Figure 1 of the biological opinion and a list of water users is found in Table 2. Additional information supporting the description of interrelated and interdependent actions and cumulative effects in the biological opinion is included below.

INTERRELATED AND INTERDEPENDENT ACTIONS AND CUMULATIVE EFFECTS

The two categories of interrelated and interdependent actions and cumulative effects differ in concept, but often overlap substantially in reality. They are considered in separate sections of the April 17, 2001 biological opinion, but will be addressed together here to provide a better picture of how they relate. In addition, there is overlap between interrelated and interdependent actions and indirect effects of the Federal action. Formal definition of each are given on Table 3 of the biological opinion, which also shows the relationship of the various types of actions, their effects, and where they are addressed in the biological opinion.

In short, indirect effects result from the Federal action without intervening State or private actions. However, there may be several intervening levels of effect, such as introduction of a nonnative invertebrate that alters nutrient cycling resulting in a lack of food for native fish causing them to be less successful at reproduction. Because of the delay in time and the intervening levels of causation, effects of actions of State, Tribal, and private entities may become intertwined making it difficult to separate the indirect effects of the Federal action from direct or indirect effects of non-Federal actions. Indirect effects are addressed as part of the overall effects and will not be further discussed in this section. Cumulative effects result from non-Federal actions in the future, but are limited to the action area and to those that will influence how effects from the proposed Federal action impact listed species.

Interdependent and interrelated actions may be action of a Federal entity other than the one in consultation or of a non-Federal entity. If they are actions of State, Tribal, or private entities they then become a part of the analysis of the ongoing consultation if they would not occur "but for" the Federal action under consultation. Because many of these interrelated and interdependent actions are ongoing, their effects also qualify for consideration as cumulative to the Federal action.

However, not all cumulative actions are interrelated and interdependent to the Federal action under consultation. Many actions that result in cumulative effects are State, Tribal and private actions totally unrelated to the Federal action under consultation, but their effects on the listed species make up part of the total picture of the resulting status of the species following implementation of the Federal action.

The CAP is a highly complex water delivery system. The role of Federal, State, Tribal, and private entities in the ownership, construction, operation, and use of CAP is almost as complex (see Table 1 of the biological opinion). Section 7 consultation is conducted only on Federal actions for which the action agency has the discretion to alter the outcome of the action. While the Bureau of Reclamation built the CAP and the Federal government retains ownership of all facilities, there are many aspects of CAP which are not presently under Federal discretion. A large portion of CAP, both directly and in use of CAP water, is under State, Tribal, and private discretion and that portion is composed of interrelated and interdependent actions that must be considered in the biological opinion analysis. While these actions and their effects are considered in the analysis, the resolution of any jeopardy, adverse modification, or incidental take must be entirely within the authority of the Federal agency in consultation. Thus, while a State, Tribal, or private interrelated or interdependent action may be part of the cause of the jeopardy, they cannot trigger section 7 consultation, and only the Federal agency is charged with removal of that jeopardy.

Even before construction of CAP was begun, some Federal discretion had already been transferred to the CAWCD, a state entity, through the Master Repayment Contract that was signed in 1972. Additional Federal discretion was transferred in the early 1980's by allocation of CAP water to other users and formalization of those by two party contracts between the Federal government and Tribes and three party subcontracts among the Federal government, CAWCD, and private water users. Federal discretion regarding where and when water is delivered through CAP was transferred to the State, except for Tribal deliveries. Federal discretion regarding many physical changes to the aqueduct and facilities has been transferred to the State. And, within broad limits set by the contracts and subcontracts, any Federal discretion regarding use of the delivery of water has been transferred to State, Tribal, and private parties.

By 1991, when formal consultation was initiated on the aspect of nonnative introduction and spread through and mediated by CAP, substantial areas of Federal discretion had already been closed. By the issuance of the biological opinion in 1994, an even larger area of Federal discretion had been transferred, when operation and maintenance were transferred to CAWCD. Prior to 1993, CAWCD had operated the system, but with a substantial input of Federal funds. After 1993, operation was with State funds. These transfers substantially narrowed the scope of what CAP activities would trigger the need for section 7 consultation, thus allowing the possibility of substantial adverse effects to listed species before a discretionary Federal action triggers consultation. But once consultation is triggered, such as by construction of the Pima Lateral and adjacent turnouts, all of those other non-Federal actions become part of the analysis.

Past CAP actions by CAWCD, the Tribes, and other water users become part of the environmental baseline and ongoing and future actions become both interrelated and interdependent and cumulative.

As discussed in the biological opinion, the primary interrelated and interdependent action for CAP in the Gila River basin is operation and maintenance of CAP, including water delivery, by CAWCD. Although this was a Federal discretionary action and part of the action under consultation when formal initiation occurred in 1991, that discretion had been transferred to the State by 1994 when the biological opinion was issued and could no longer be considered a part of the Federal action under consultation. It then became an interdependent and interrelated action, to be considered as a part of the overall effects, but not as part of the action available for modification as a resolution to jeopardy, adverse modification, or incidental take.

In addition to those interdependent and interrelated actions that are directly part of the CAP system, there are a number of actions that result from the delivery of the water. They would not occur "but for" the availability of that water. Burgeoning human population in the basin and the resulting expanding urban, suburban, and small-lot ranchette development has been increased as a result of water made available by CAP. Reclamation does not believe that such development should be considered as interrelated and interdependent to CAP. Their position for this consultation and other environmental compliance, is that growth in Arizona would occur at the same level with or without the CAP and its water supply. However, while some would agree with this belief in the abundant availability of other water supplies in central Arizona (Welsh 1985, GRIC 2001), it is not shared by many others (Mann 1963, Folk-Williams 1991, CAWCD 1995, Pearson 1998). A recent study by the Morrison Institute for Public Policy at Arizona State University (2000:3), concludes:

> *Although the region has ample water for its current population, water management will be more important given that there are no potential projects on the scale of the Central Arizona Project to increase the future water supply. As such, water management will become increasingly related to growth management, as water becomes an invaluable regulator by influencing where homes and businesses may locate.*

In fact, the initial EIS for the CAP states as objectives of the project "to provide a water supply for municipal and industrial uses"(inside the central service area), "to provide the central Arizona Indian communities with new economic and social stimulation," and "to enhance the economic development potential of service areas outside the central service area." and further states that "the water will be used to support municipal and industrial development" (USBR 1972).

The 1972 EIS recognized that meeting those objectives would result in accelerated population growth, although the EIS felt that the increase would be small. However, EIS growth estimates for the year 2000 in the central service area of Maricopa, Pinal, and Pima counties was already exceeded by 1990 (ADES 2001) presumably because "The availability and use of CAP water helps position Arizona as one of the most desirable locations to live, work, and play in the nation" (U.S. Water News Online 1997). Although partially fueled by CAP water, increased growth will also result in increased groundwater pumping, thus threatening surface water flows. Human population growth thus becomes an indirect effect, an interdependent and interrelated action, and/or a cumulative effect of the delivery of CAP water in the Gila River basin.

In the Gila basin changes in human population are very uneven, with smaller towns and rural areas losing population and the medium to large towns and cities increasing in population. However, rapid growth is common in areas which receive water through CAP or which have benefitted from increased surface or groundwater as a result of CAP water becoming available elsewhere. While water from the Salt River Project has in the past been the main supply for the Phoenix area, much of the recent and future growth will be based on water from CAP. About half of the CAP aqueduct turnouts are in the Phoenix area, with water being furnished to metropolitan area towns of Tonopah, Goodyear, Buckeye, Litchfield Park, Sunrise, Sun City, Anthem, Glendale, Peoria, Avondale, Phoenix, Cave Creek, Carefree, Paradise Valley, Rio Verde, Fountain Hills, Scottsdale, Tempe, Mesa, Chandler, Gilbert, Apache Junction, and Queen Creek (USBR 2001).

The largest urban area in the basin is the greater Phoenix metropolitan area, which is the seventh largest in the nation. Over the past decade the growth rate in Phoenix and its suburbs has been very high. Table 3 shows a selection of these growth rates and projections for the upcoming decade. Although growth in these locations is expected to slow, the rates of growth will remain quite high. In addition, some communities which receive their water supply from CAP, such as Anthem, are new developments whose population figures are not tracked by ADES. Anthem, which did not exist in 1998, is now under construction and is expected to have 16,500 new homes.

In addition, several Native American Tribes and smaller outlying cities received CAP allocations. To effectuate those allocations, most of these entities are trading CAP water for surface water rights or for funds to develop groundwater or buy other water rights. Excluding those in the Santa Cruz River subbasin, tribes include the Ft. McDowell Mohave-Apache Community, Gila River Indian Community, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tonto Apache, and Yavapai-Prescott Tribe. Outlying cities with CAP allocations include Camp Verde, Cottonwood, Globe, Payson, Florence, Mayer, and Prescott. In addition, the State of New Mexico received an allocation. Growth in many of these areas is rapid and expected to remain high (Table 3).

Table 3. Human Population Growth in Selected CAP Delivery Areas or CAP "Exchange" Areas (ADES 2001)

TOWN OR CITY	ANNUAL GROWTH OVER PAST DECADE	ANNUAL PROJECTED GROWTH FOR NEXT DECADE
Gilbert	27%	7%
Goodyear	21%	9%
Peoria	11%	5%
Prescott Valley (exchange)	16%	5%
Chandler	10%	3%
Buckeye	9%	6%
Fountain Hills	9%	9%
Scottsdale	6%	3%
Payson (exchange)	6%	3%
Cottonwood (exchange)	6%	1%
Queen Creek	5%	9%
Glendale	4%	2%
Mesa	4%	3%
Prescott (exchange)	4%	2%
Cave Creek	3.5%	11%
Globe (exchange)	3%	1%
Phoenix	3%	2%
Litchfield Park	2%	7%

Human population and development increases are expected to result in adverse impacts to all native fish and aquatic fauna of the Gila River basin through a variety of mechanisms including flow depletion, habitat alteration, and nonnative species enhancement. Human activities within a watershed affect streams in many ways. On a broad scale, the removal of vegetation or its replacement by nonnative species and the increased amount of surface that is paved or built upon will result in substantial changes in watershed function (Dunne and Leopold 1978, Leopold 1994, Baker *et al*. 1998). Stream flows become more unstable, with high, short peak floods and extended, low (or vanished) base flows. Erosion increases with subsequent aggradation or degradation of the receiving channels. On a more localized scale, riparian vegetation will be removed and streambanks will be altered to support buildings and roads, and streams will be increasingly channelized to prevent flood damage to those buildings and roads from the action of the higher peak floods acting upon the destabilized streambanks (see Pearthree and Baker 1987). Although these actions are localized, their effects may extend for miles upstream and downstream.

While the CAP water supplies will increase human population in the Gila River basin, that in turn will fuel the need for additional water development. This will be particularly acute in areas of CAP "exchanges" where outlying communities exchange or sell their CAP allocations for funds with which to develop additional surface or groundwater supplies. The increased water development for human use will continue to deplete stream flows and alter natural hydrographs, thus destroying or adversely modifying the habitat for all native fishes and other aquatic fauna, including those being considered in this opinion. Three biological opinions of effects of these "exchanges" to endangered and threatened fish and other species have already been issued, one for the upper Gila River in New Mexico, one for the upper Verde River, and one for the middle Verde River (see Table 1 and Appendix 3). Those opinions addressed that portion of additional water development resulting from CAP allocations that involve Federal action and therefore the losses incurred to listed species become part of the environmental baseline of this biological opinion. However, many of the actions taken to develop additional water, due to CAP allocations and their induced growth, do not involve Federal actions, funds, or permits. But, those actions are dependent upon CAP for their justification, therefore they are interrelated to the CAP and their effects must be considered as part of the analysis of the consultation. They may also be considered an indirect effect of the proposed Federal action. To the extent to which some of this water development might occur in the absence of CAP, using water from other sources, those uses may not be interrelated and interdependent, but are cumulative to the Federal CAP action.

As the human population increases in the basin, there will also be accelerating demand for use of public lands and creation of impounded waters for recreation (see US Army Corps of Engineers 1997). In addition to the watershed and streambank alteration involved, increasing recreation raises the likelihood of human introduction and transport of nonnative aquatic species through a variety of mechanisms. Increasing recreation causes greater demand for sport fish stocking and encourages live bait use (see USFWS 2001b and c). Demand for additional recreational opportunities leads to increased construction of impounded waters, which often destroys native species habitat and provides aquatic habitat that favors nonnative species over natives. Increasing recreation results in frequent and prolonged contact between people and surface waters, thereby raising the likelihood of people dumping nonnative aquatic species, moving them from place to place, or unintentionally transporting them attached to clothing, vehicles, boats, and equipments (e.g. zebra mussel and giant salvinia).

Wetlands, impoundments, and streamflows established for recharge purposes using CAP water may be used to satisfy many of these recreational needs and so play both a direct and an interdependent and interrelated role. Creation of wetlands or impoundments may clearly be a part of the proposed action if the water placed into these water bodies is delivered from CAP, as it is in the Granite Reef Underground Storage Project (see USBR 2001). However, some may not directly use CAP water but may still be interrelated and interdependent actions to the proposed CAP action under 1 of 2 conditions: 1) if they would not occur except to implement CAP deliveries, or 2) if they would not occur had CAP water had not been available to fill consumptive uses for which the non-CAP water would have otherwise been used.

STATUS AND DESCRIPTION OF THE SPECIES

SPIKEDACE

Spikedace was listed as a threatened species on July 1, 1986 (USFWS 1986a). Critical habitat was designated for spikedace on March 8, 1994 (USFWS 1994b), but was set aside by order of the federal courts in Catron County Board of Commissioners, New Mexico V. U.S. Fish and Wildlife Service, CIV No. 93-730 HB (D.N.M., Order of October 13, 1994). Critical habitat was subsequently revoked by the Service (USFWS 1998a). It was again designated on April 25, 2000 (USFWS 2000). Critical habitat includes portions of the Verde, middle Gila, San Pedro, San Francisco, Blue, and upper Gila Rivers and Eagle, Bonita, Tonto, and Aravaipa Creeks and several tributaries of those streams.

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

Spikedace lives in flowing water with moderate to fast velocities over sand, gravel, and cobble substrates (Propst *et al*. 1986, Rinne and Kroeger 1988). Specific habitat for this species consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at the downstream riffle edges (Propst *et al*. 1986). Spikedace spawns from March through May with some yearly and geographic variation (Barber *et al*. 1970, Anderson, 1978, Propst *et al*. 1986). Actual spawning has not been observed in the wild, but spawning behavior and captive studies indicate eggs are laid over gravel and cobble where they adhere to the substrate. Spikedace lives about two years with reproduction occurring primarily in one-year old fish (Barber *et al*. 1970, Anderson 1978, Propst *et al*. 1986). It feeds primarily on aquatic and terrestrial insects (Schreiber 1978, Barber and Minckley 1983, Marsh *et al*., 1989).

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

The status of spikedace is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted. A reclassification proposal is pending, however, work on it is precluded due to work on other higher priority listing actions (USFWS 1994c). Although spikedace is common in some portions of its highly reduced range, it is uncommon to rare in most. At present, the species is common only in Aravaipa Creek and some parts of the upper Gila River in New Mexico. Populations in the Verde River and Eagle Creek have not been found since 1999 and 1987, respectively and their status is uncertain (AGFD unpublished data, Marsh *et al*. 1989, Rinne 1999).

LOACH MINNOW

Loach minnow was listed as a threatened species on October 28, 1986 (USFWS 1986b). Critical habitat was designated for loach minnow on March 8, 1994 (USFWS 1994d), but was set aside by order of the federal courts in Catron County Board of Commissioners, New Mexico V. U.S. Fish and Wildlife Service, CIV No. 93-730 HB (D.N.M., Order of October 13, 1994). Critical habitat was subsequently revoked by the Service (USFWS 1998a). It was again designated on April 25, 2000 (USFWS 2000). Critical habitat includes portions of the Verde, Black, middle Gila, San Pedro, San Francisco, Tularosa, Blue, and upper Gila Rivers and Eagle, Bonita, Tonto, and Aravaipa Creeks and several tributaries of those streams.

Loach minnow is a small, slender, elongate fish with markedly upwardly-directed eyes (Minckley 1973). Historic range of loach minnow included the basins of the Verde, Salt, San Pedro, San Francisco, and Gila Rivers (Minckley 1973, Sublette *et al*. 1990). Habitat destruction plus competition and predation by nonnative species have reduced the range of the species by about 85 percent (Miller 1961; Williams *et al*. 1985; Marsh *et al.* 1989). Loach minnow remains in limited portions of the upper Gila, San Francisco, Blue, Black, Tularosa, and White Rivers and Aravaipa, Turkey, Deer, Eagle, Campbell Blue, Dry Blue, Pace, Frieborn, Negrito, Whitewater, and Coyote Creeks in Arizona and New Mexico (Barber and Minckley 1966, Silvey and Thompson 1978, Propst *et al*. 1985, Propst *et al*. 1988, Marsh *et al*. 1990, Bagley *et al*. 1995, USBLM 1995, Bagley *et al.* 1996, Miller 1998).

Loach minnow is a bottom-dwelling inhabitant of shallow, swift water over gravel, cobble, and rubble substrates (Rinne 1989, Propst and Bestgen 1991). Loach minnow uses the spaces between, and in the lee of, larger substrate for resting and spawning (Propst *et al.* 1988; Rinne 1989). It is rare or absent from habitats where fine sediments fill the interstitial spaces (Propst and Bestgen 1991). Some studies have indicated that the presence of filamentous algae may be an important component of loach minnow habitat (Barber and Minckley 1966). The life span of loach minnow is about 2 years (Britt 1982; Propst and Bestgen 1991). Loach minnow feeds exclusively on aquatic insects (Schreiber 1978; Abarca 1987). Spawning occurs in March through May (Britt 1982; Propst *et al*. 1988); however, under certain circumstances loach minnow also spawn in the autumn (Vives and Minckley 1990). The eggs of loach minnow are attached to the underside of a rock that forms the roof of a small cavity in the substrate on the downstream side. Limited data indicate that the male loach minnow may guard the nest during incubation (Propst *et al.* 1988; Vives and Minckley 1990).

Recent biochemical genetic work on loach minnow indicate there are substantial differences in genetic makeup between remnant loach minnow populations (Tibbets 1993). Remnant populations occupy isolated fragments of the Gila River basin and are isolated from each other. Based upon her work, Tibbets (1992, 1993) recommended that the genetically distinctive units of loach minnow should be managed as separate units to preserve the existing genetic variation.

The status of loach minnow is declining rangewide. Although it is currently listed as threatened, the Service has found that a petition to uplist the species to endangered status is warranted. A reclassification proposal is pending, however, work on it is precluded due to work on other higher priority listing actions (USFWS 1994c). In its highly reduced remaining range, loach minnow varies from common to rare. At present, the species is common only in Aravaipa Creek, the Blue River, and limited portions of the San Francisco, upper Gila and Tularosa Rivers. Remnant populations in the Black, White, and Eagle Creeks are very small and their continued existence is tenuous.

GILA TOPMINNOW

Gila topminnow was listed as endangered in 1967, without critical habitat (USFWS 1967). Only the Gila topminnow populations in the United States, not in Mexico, are listed. The omission of the Mexican portion of its range was based on legal and political considerations and was not related to biology or status (Weedman 1998). The entire species with the United States is listed, including both the Gila subspecies *Poeciliopsis occidentalis occidentalis* and the Yaqui subspecies *P. o. sonoriensis*. Additional information indicates these subspecies may be substantially different, possible at the species level (W.Minckley, ASU, pers. comm., 1997). Only the Gila subspecies is found within the Gila River drainage and is thus considered in this consultation.

Gila topminnow is a small live-bearing fish of the family Poeciliidae. Males are smaller than females, rarely greater than 1 inch (25 millimeters), while females are larger, reaching 2 inches (51 millimeters). They are tan to olivaceous, darker above and lighter below. Breeding males are usually black with some golden coloration of the midline and with orange or yellow at the base of the dorsal fin.

Historically Gila topminnow was abundant in the Gila River drainage and was one of the most common fishes of the Colorado River basin (Hubbs and Miller 1941). Presently only 12 natural

Gila topminnow populations remain extant (Table 4) (Weedman and Young 1997, AGFD 1998a). Only three of those populations (Cienega Creek, Monkey Spring, Cottonwood Spring) have no nonnative fish present and therefore can be considered secure.

Table 4. Status of natural Gila topminnow populations in the US.

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

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

There have been at least 175 will sites stocked with Gila topminnow, however, topminnow persist at only 16 of these localities (AGFD 1998a). Of the 16, one site is outside of the species' historic range and three contain nonnative fish (Weedman and Young 1997). The recovery plan for the species established down-listing criteria (Stefferud 1984), that were met for a short period in the early 1990s. However, due to concerns regarding the status of several populations, down-listing was delayed. Subsequently, the number of reintroduced populations dropped below that required for down-listing, and has remained below that level.

Natural populations are considered more important for recovery than stocked populations for a variety of reasons. Each natural population contains slightly different genetic makeup (Hedrick and Parker 1999, Parker *et al*. 1999) and loss of any natural population represents a permanent loss to the genetic diversity of the species that may be of importance to adaptability of the species (Leberg and Vrijenhoek 1994, Sheffer *et al*. 1997). The natural habitats that support the natural populations have proven to sustain themselves over time, providing insight on habitat conditions important to recovery planning. The few remaining larger natural populations, such as Cienega Creek and Redrock Canyon provide slightly larger areas in which the Gila topminnow can retain its natural expansion and contraction pattern. The Bylas Springs complex (including Salt Creek and Middle Spring) has the only remnant population from the entire northern Gila basin portion of the historic range. Habitat that support introduced populations are generally small, isolated, and some are human constructed, such as stock tanks, thus they do not represent natural conditions that the species historically encountered. In addition, or perhaps for these reasons, natural populations have a higher degree of persistence than stocked populations and natural habitats have a higher level of habitat diversity than found in stocked habitats. The draft revised recovery plan established *Survival Criteria* that call for prevention of extinction as the highest and most urgent priority in the recovery program for Gila topminnow (Weedman 1998). Securing the long-term survival of the existing natural populations if the first step in meeting those criteria.

Gila topminnow fertilization is internal and sperm is stored to fertilize subsequent broods (Constantz 1981). Brood time is 24 to 28 days, and two to three broods, in different stages of development, are carried simultaneously. Gila topminnow gives birth to 1 to 31 young per brood (Schoenherr 1974). Young mature in a few weeks to many months after birth, depending upon when they are born. Breeding is primarily from March to August, but some pregnant females occur throughout the year particularly in thermal waters (Schoenherr 1974). Gila topminnow is short-lived with an average natural live span of less than a year (Minckley 1999). Minckley (1973) and Constantz (1980) reported that Gila topminnow is an opportunistic feeder which eats bottom debris, vegetation, amphipods, and insect larvae when available.

Gila topminnow can tolerate a wide variety of physical and chemical conditions. They are good colonizers, in part because of this tolerance, and in part because a single gravid female can start a population (Meffe and Snelson 1989). Gila topminnow is known to occur in streams fluctuating from 51 to 99° Fahrenheit (6 to 37° Centigrade). However, Minckley (1999) has hypothesized that prolonged or extreme winter cold may contribute to loss of populations, except in places where groundwater exchange or other factors ameliorate local water temperatures.

Minckley (1999) describes their historic habitat as a variety of shorelines and slackwaters of rivers to small streams, springs, and marshes. They exhibited a pattern of expansion and contraction of their occupied areas in concert with environmental conditions. Today, only the latter of those are occupied by Gila topminnow, which occupy shallow water in slow currents, tending to concentrate in protected inlets, shoreward of sandbars or debris, or associated with aquatic or streamside vegetation (Minckley 1973, Meffe *et al*. 1983, Forrest 1992). Although substrate is not of great importance, they occur more frequently over sand substrates than over other types (Simms and Simms 1991). At present the occupied habitats are all isolated from each other and the natural expansion and contraction pattern has been destroyed.

Gila topminnow are highly vulnerable to adverse effects from nonnative aquatic species (Johnson and Hubbs 1989). Predation and competition from nonnative fishes have been a major factor in their decline and continue to be a major threat to the remaining populations (Meffe *et al*. 1983, Meffe 1985, Brooks 1986, Marsh and Minckley 1990, Stefferud and Stefferud 1994, Weedman and Young 1997, Minckley 1999). The native fish fauna of the Gila River basin and of the Colorado basin in general, was naturally depauperate and contained few fish that were predatory on, or competitive with, Gila topminnow (Carlson and Muth 1989). In the riverine backwater and side-channel habitats that formed the bulk of Gila topminnow natural habitat, predation and competition from other fishes was essentially absent (Minckley 1999). Thus Gila topminnow did not evolve mechanisms for protection against predation or competition and is predator and competitor-naive. With human introduction of large numbers of predatory and competitive nonnative fish, frogs, crayfish, and other species, Gila topminnow could no longer survive in many of their former habitats, or the small pieces of those habitats that had not been lost to human alteration.

The status of Gila topminnow is poor and declining. Gila topminnow has gone from being one of the most common fishes of the Gila basin to one that exists in less than 30 localities. Many of these localities are small and threatened. The theory of island biogeography can be applied to these isolated habitat remnants, as they function similarly (Meffe 1983, Laurenson and Hocutt 1985). Species on islands are more prone to extinctions than continental areas that are similar in size (MacArthur and Wilson 1967). Moyle and Williams (1990) noted that fish in trouble tend to be endemic, restricted to a small area, part of native fish communities with fewer than five species, and found in isolated springs or streams; all of which apply to the present status of Gila topminnow.

RAZORBACK SUCKER

Razorback sucker was listed as endangered on October 23, 1991 (USFWS 1991). Critical habitat was designated for razorback sucker on March 21, 1994 (USFWS 1994e). Within the Gila River basin, critical habitat includes portions of the Gila, Verde, and Salt Rivers. Critical habitat includes the river and its 100-year floodplain.

Razorback sucker grows to over two feet (60 centimeters) in length and has a distinctive, abrupt, sharp-edged dorsal ridge behind the head (Minckley 1973). Adult razorback sucker inhabit a wide variety of riverine habitats including mainstream and backwater areas such as slow runs, deep eddies, pools, and sloughs (Bestgen 1990). It also inhabits reservoirs. Larval and juvenile razorback sucker habitat includes shallow, slow moving areas, backwaters and littoral zones (Langhorst and Marsh 1986, Bestgen 1990). Razorback sucker spawns from January to May and initiation of spawning appears to be tied to water temperature (Langhorst and Marsh 1986, Tyus and Karp 1990). Spawning occurs in shallow water over large gravel, cobble, or coarse sand with little or no fine sediment, on wave-washed lakeshores, or on riverine riffles (Minckley *et al*. 1991). Razorback sucker lives up to about 50 years (McCarthy 1987). It feeds on plankton, algae, and detritus in reservoirs, with riverine populations also consuming a large amount of benthic invertebrates (Bestgen 1990).

The species was once common throughout the Colorado River basin, but is now rare. Habitat alteration and destruction, along with competition and predation from introduced nonnative fish species, are responsible for the species' decline (Marsh and Brooks 1989, Minckley *et al*. 1991).

In the upper Colorado basin, razorback sucker now occur sporadically in about 750 miles (1,200 kilometers) of stream (Bestgen 1990), including the middle Green River, upper Colorado, Gunnison, White, Duchesne, and Yampa Rivers (Modde *et al*. 1996, SWCA 2000). A small population also persists in the San Juan River (J. Brooks, USFWS, pers. comm.). Only the Green River population is thought to have recruitment, although that is based on length-frequency data and not on direct observation (Modde *et al.* 1996). Augmentation, using hatchery stocks, is occurring in the Green, Gunnison, Colorado, and San Juan Rivers, and Lake Powell.

In the lower basin, razorbacks persist on the Colorado River in Lakes Mead, Mohave, and Havasu and in the mainstem between the reservoirs and downstream of Lake Havasu. Only the population in Lake Mohave is of substantial size (Pacey and Marsh 1999). Augmentation stocking from hatchery or semi-natural ponds is occurring in Lakes Mohave and Havasu. Spawning by razorback suckers has been documented in Lakes Mead and Mohave and recruitment has been documented in Lake Mead (Sjoberg 1995, Holden *et al*. 1999).

As part of the recovery program, reintroduction of razorback sucker has been attempted through stocking into numerous locations in the Gila, Salt, and Verde River basins (Creef *et al*. 1992, Hendrickson 1993). Of those, only the Salt and Verde locations were stocked repeatedly. It is unknown as yet whether razorback sucker will establish reproducing populations in any of these locations. Only the Salt and Verde populations are regularly monitored and survivorship appears to be low (AGFD 1998b).

The range-wide status of the razorback sucker is extremely poor. Populations of wild-born and naturally recruited fish continue to decline, as populations are reaching senescence. The largest extant wild population in Lake Mohave has declined to fewer than 10,000 wild individuals in the late 1990's from a high of over 60,000 in the early 1980's (Pacey and Marsh 1999) as fish die of old age. Augmentation of captive reared young adults to these populations has a measure of success in as much as the young adults are found with the old adults in the spawning areas. Based on recapture data, Pacey and Marsh (1999) estimated that 25% of the Lake Mohave population was made up of repatriated young adults. While repatriation and augmentation to existing populations may prolong the existence of the adult razorback populations in the wild, they do not solve the problem of nonnative species adverse effects on recruitment. Nonnative species still prey on the eggs and early life stages, precluding recruitment by young adult razorbacks. Additionally, repatriation and augmentation efforts are limited by the presence of nonnative species in that razorbacks must be stocked at larger sizes to reduce the risk of predation and competition from nonnatives. Stocking of small razorbacks was shown to have very limited success (Marsh and Brooks 1989), so now razorbacks are stocked at 10 inches (25 centimeters). Greater numbers of razorbacks at smaller sizes could be reared for release, which would help to increase wild populations faster, but the effort is severely compromised by reduced survival of the stocked individuals. Thus, nonnative species have adverse effects on the outcome of extant recovery and species survival efforts as well as on natural recruitment. Unless existing nonnative aquatic species in razorback habitats are reduced, and additional nonnative invasion is prevented, survival of the species remains in doubt and efforts to at minimum keep the existing populations from being extirpated are made more difficult and expensive to undertake.

DESERT PUPFISH

Desert pupfish was listed as an endangered species, with critical habitat, on April 30, 1986 (USFWS 1986c). Critical habitat was designated in Arizona at Quitobaquito Springs in Pima County and in California along parts of San Felipe Creek, Carrizo Wash, and Fish Creek Wash. None of the critical habitat is within the Gila River basin. At the time of listing there were two recognized species of desert pupfish, *Cyprinodon macularius macularius*, and the Quitobaquito pupfish *Cyprinodon macularius eremus* (McMahon and Miller 1982, Miller and Fuiman 1987). Since then, the two subspecies have been redescribed as distinct species, with the desert pupfish being found in the Gila, lower Colorado, and Salton Sea basins and the Quitobaquito pupfish being found in the Rio Sonoyta basin (Echelle *et al*. 2000).

The desert pupfish is a small fish, less than 3 inches (8 centimeters) long (Minckley 1973). Males are larger than females and become bright blue during the breeding season. Spawning occurs from spring through autumn, but reproduction may occur year-round depending on conditions (Constantz 1981). Eggs are laid loose over soft substrates. Under limited breeding habitat and high population densities, males are highly territorial and patrol and defend territories (Barlow 1961). Females lay only one egg at a time but one female produces 50-800 eggs per season (Constantz 1981). The life span of an individual is one to three years (Minckley 1973, Kynard and Garrett 1979). Desert pupfish feeds on invertebrates, algae, and organic debris (Minckley 1973, Naiman 1979).

Desert pupfish lives in ponded or slow-flowing water in what was historically a wide variety of habitats including springs and marshes, small streams, and edges and backwaters of larger rivers (Hendrickson and Varela Romero 1989). Remaining occupied habitats are small streams and springs (Marsh and Sada 1993). The species has extraordinary ability to tolerate a wide variety of water temperature and quality (Kinne and Kinne 1962, Marsh and Sada 1993).

Desert pupfish was once common throughout the mid to lower portions of the Gila River basin, the lower Colorado River and its delta, and the Salton Sea basin of California (Minckley 1985). It was extirpated from the Gila basin by the mid-1900's (Minckley 1973). The reasons for its extirpation were primarily dewatering of major portions of its habitat and the invasion of the remainder by predatory and competitive nonnative species (Matsui 1981, Hendrickson and Minckley 1984, Minckley 1985, Schoenherr 1988) The only remaining natural populations of desert pupfish are isolated localities in the Salton Sea basin of California and the lower Colorado delta in Mexico (Hendrickson and Varela-Romero 1989, Lau and Boehm 1991, Minckley 2000). Attempts at stocking in the Gila River basin have been largely unsuccessful and only two populations are extant (Boyce-Thompson Arboretum and Cold Springs Seep), both in small, isolated spring systems (Weedman and Young 1997). The range-wide status of desert pupfish is poor but stable. The future of the species depends heavily upon future developments in water management of the Salton Sea and Santa Clara Cienega in Mexico.

COLORADO SQUAWFISH

Colorado squawfish, also known as pikeminnow, is a large fish listed as endangered since 1967 (USFWS 1967). Critical habitat was designated in 1994 and includes portions of the Yampa, Green, White, Gunnison, San Juan, and Colorado Rivers in Colorado, Utah, and New Mexico (USFWS 1994e). Critical habitat was not designated in the Gila River basin because of a 1985 designation of the Salt and Verde Rivers as locations for experimental non-essential populations of Colorado squawfish (USFWS 1985b). Such populations cannot be included in critical habitat.

Colorado squawfish lives in the mainstream of larger rivers, with use of backwaters and eddies during some seasons and by young fish (Tyus 1991. It spawns in late spring through summer, making extensive migrations to appropriate shallow, coarse-bottomed habitat (McAda and Kaeding 1991, Tyus 1991). Colorado squawfish is believed to live up to 30 years (Tyus 1991) and is carnivorous, eating mainly insects when young and fish when adult (Vanicek and Kramer 1969, Muth and Snyder 1995).

Colorado squawfish was once found in Gila, San Pedro, Salt, and Verde Rivers, but was extirpated from the basin by 1970 (Tyus 1991). The species' decline is due primarily to habitat destruction and alteration, and fragmentation by human activities and by the introduction and spread of nonnative aquatic species (Minckley 1985, Minckley 1991, Bestgen *et al*. 1998, Tyus and Saunders 2000). Colorado squawfish still occurs in several locations in the upper Colorado River basin (Tyus 1991, Platania *et al*. 1991). It has been reintroduced into the Gila River basin in the Verde and upper Salt Rivers, but with limited success (Hendrickson 1993, AGFD 1998b) . The range-wide status of Colorado squawfish is moderate due to limited recruitment, continued habitat loss, and continuing pressure from nonnative species.

GILA TROUT

Gila trout was listed as endangered in 1967 (USFWS 1967). Critical habitat has not been designated. In 1987, Gila trout was proposed for reclassification to threatened status however that proposal was withdrawn due to setbacks in recovery from fire, reinvasion of nonnatives, and flooding (USFWS 1987).

The historic range of Gila trout includes the drainages of the upper Gila, San Francisco, Blue, Agua Fria, and Verde Rivers, and Eagle Creek (Pittenger 1993). Gila trout was once common in the headwater streams of the those drainages (Miller 1950, Mulch and Gamble 1956, Miller 1972, Behnke and Zarn 1976). By 1950, the species was confined to a few, severely fragmented, small headwater streams in the upper Gila and San Francisco Rivers in New Mexico (Sublette *et al*. 1990, Propst *et al*. 1992). The species' decline is due primarily to habitat destruction and alteration and by the introduction and spread of nonnative aquatic species, particularly rainbow trout, which hybridize with Gila trout (Miller 1950, 1961, Propst *et al*. 1992, Propst and Stefferud 1997).

Natural populations of Gila trout remain in four small headwater streams in New Mexico; Main Diamond, South Diamond, Spruce, and Whiskey Creeks and (Pittenger 1993, Propst and Stefferud 1997). Extensive recovery efforts over the past 20 years have resulted in removal of nonnative trouts and repatriation of replicates of all of those populations into eight additional streams in the upper Gila and San Francisco drainage (Propst *et al*. 1992, Pittenger 1993, Propst 1999). In addition, populations have been repatriated in Dude Creek in the upper Verde River basin and Raspberry Creek in the Blue River basin. Additional repatriation efforts are expected throughout the historic range.

Gila trout lives in small headwater streams using pools for resting and riffles for feeding (Hanson 1971, Rinne 1978, Propst *et al*. 1992). Spawning occurs from early April at lower elevations through June at higher elevations (Rinne 1980). Spawning occurs in fine gravel and coarse sand (Pittenger 1993). Gila trout is an opportunistic feeder using a wide variety of aquatic invertebrates (Regan 1964).

The status of Gila trout has been improving over the past 20 years due to extensive recovery efforts. Continued success in these efforts requires the ability to control and remove nonnative aquatic species that threaten Gila trout. Potential repatriation streams in the Verde, Blue, San

Francisco, Agua Fria, and Eagle Creek subbasins must be kept free of any additional nonnative species and existing nonnatives must be removed.

APACHE TROUT

Apache trout was listed as endangered in 1967, and reclassified to threatened in 1975 (USFWS 1967, 1975). Critical habitat has not been designated. This historic range of Apache trout included most of the streams above about 5,500 feet (1,675 meters) elevation in the east central White Mountains of Arizona, which includes the headwaters of the Salt and Little Colorado Rivers (Miller 1972, Behnke 1992). Habitat loss, overfishing, and predation and competition from introduced nonnative trout species greatly reduced the numbers and distribution of Apache trout (USFWS 1993). Hybridization with nonnative rainbow trout was a primary factor in their decline and continues to be a factor in their recovery (Dowling and Childs 1992).
By 1950, the only known populations of Apache trout were on the Fort Apache Indian Reservation. Extensive recovery efforts have been undertaken for Apache trout, primarily removal of nonnative species and repatriation of Apache trout (Rinne *et al*. 1982, USFWS 1993) Natural populations of Apache trout are presently found 12 streams on the Fort Apache Indian Reservation and 12 replication populations on the Reservation and the Apache-Sitgreaves National Forests (USFWS unpub. data). One of those populations, plus one on the Kaibab National Forest are outside of the historic range. Extensive hatchery propagation and repatriation efforts, combined with removal of nonnative trouts, has resulted in a range-wide status for Apache trout that is good and improving.

Apache trout are a brightly colored medium-sized fish with uniform dark spots on the sides (Minckley 1973). It lives in small headwater streams using pools for resting and riffles for feeding although most occupied streams have low pool-riffle ratios (USFWS 1993). It spawns from March through mid-June over gravel substrates (Harper 1978). Apache trout feeds mainly on aquatic insects (USFWS 1993).

The status of Apache trout is good and improving. This is due to the extensive hatchery propagation and repatriation efforts, along with habitat improvement work. Additional repatriations are planned. Removal and control of nonnative species is a major part of the recovery program.

BALD EAGLE

Bald eagle, south of the 40^{th} parallel, was listed as endangered in 1978, but was reclassified as threatened in 1995 (USFWS 1978, 1995a). Critical habitat is not designated. The Service is presently considering delisting of the species (USFWS 1999b). The bald eagle is a large hawk that historically ranged throughout North America except extreme northern Alaska and Canada and central and southern Mexico. Bald eagles nested on both coasts of the United States, from

Florida to Baja California in the south, and from Labrador, New Foundland to the Aleutian Islands, Alaska, in the north.

The bald eagle occurs in association with aquatic ecosystems, frequenting estuaries, large lakes, reservoirs, major rivers, and some seacoast habitats. Suitable habitat for bald eagles includes those areas with an adequate food base, perching areas, and nesting sites. In winter, bald eagles often congregate at specific wintering sites that are generally close to open water and that offer good perch trees and night roosts (USFWS 1995a). The southwestern, desert-nesting population of bald eagle nests along large rivers and streams, using cliff ledges and pinnacles and large riparian trees and snags (cottonwood, willow, sycamore, juniper, pinyon, and ponderosa pine) (AGFD 2000a).

There were an estimated one-quarter to one-half million bald eagles on the North American continent when Europeans first arrived. Initial populations declines probably began in the late 1800's and coincided with declines in the number of waterfowl, shorebirds, and other prey species. Direct killing of bald eagles was also prevalent. Additionally, there was a loss of nesting habitat. These factors reduced bald eagle numbers until the 1940's when protection for the bald eagle was provided through the Bald Eagle Protection Act (16 U.S.C. 668). The Act accomplished protection and a slower decline in bald eagle populations by prohibiting numerous activities adversely affecting bald eagles and increasing public awareness of the bald eagle. The widespread use of dichloro-diphenyl-trichloroethane (DDT) and other organochlorine compounds in the 1940's for mosquito control and as a general insecticide caused additional declines in the bald eagle populations. DDT accumulated in individual birds following digestion of contaminated food. DDT breaks down into dichlorophenyl-dichloroethylene (DDE) and accumulates in the fatty tissues of adult females, leading to impaired release of calcium necessary for egg shell formation. Thinner egg shells led to reproductive failure, and is considered a primary cause of declines in the bald eagle population. DDT was banned in the United States in 1972 (USFWS 1995a).

Since listing, bald eagles have increased in number and expanded in range due to the banning of DDT and other persistent organochlorine compounds, habitat protection, and recovery efforts. Surveys in 1963 indicated 417 active nests in the lower 48 states with an average of 0.59 young produced per nest. In 1994, 4,450 occupied breeding areas were reported with an estimated average of 1.17 young produced per occupied nest (USFWS 1995a).

Hunt *et al*. (1992) summarized the earliest records of bald eagles in the literature for Arizona. Coues noted bald eagles in the vicinity of Fort Whipple (now Prescott) in 1866, and Henshaw reported bald eagles south of Fort Apache in 1875. The first bald eagle breeding information was recorded in 1890 near Stoneman Lake by S.A. Mearns. Additionally, Bent reported breeding eagles at Fort Whipple in 1866 and on the Salt River Bird Reservation (since inundated by Roosevelt Lake) in 1911. Additionally, there are reports of bald eagles along rivers in the White

Mountains from 1937, and reports of nesting bald eagles along the Salt and Verde Rivers as early as 1930.

From 1970 to 1990, 226 known eaglets fledged in Arizona, for an average of 10.8 young produced per year. Successful nests contained an average of 1.6 young per year (Hunt *et al*. 1992). In 1996, there were 36 known breeding areas, with 30 of those being occupied. Within those breeding areas, 31 were active, meaning eggs or young were present. Fifteen nesting attempts were successful, with 25 young fledged (Beatty *et al*. 1997). At present, there are 42 territories in Arizona and about 4 pair in New Mexico.

In addition to breeding bald eagles, Arizona provides habitat for wintering bald eagles, which migrate through the state between October and April each year. The most concentrated populations of wintering bald eagles is found at Lake Mary and Mormon Lake (Beatty and Driscoll 1996).

It is not known if the population of bald eagle in Arizona declined as a result of DDT contamination because records were not consistently kept during this time period. However, the possibility for contamination was present as DDT was used in Arizona and Mexico. Use of DDT in Mexico could potentially have contaminated waterfowl that then migrated through Arizona, in addition to directly affecting juvenile and subadult eagles that traveled into Mexico. Many of the nest sites in Arizona are in rugged terrain not suitable for agricultural development, and may therefore have avoided the direct effects of DDT (Hunt *et al*. 1992).

Bald eagle breeding areas in Arizona are predominantly located in the upper and lower Sonoran life zones. The Luna Lake breeding area is unique in Arizona in that it is found in coniferous forests. All breeding areas in Arizona are located in close proximity to a variety of aquatic habitats including reservoirs, regulated river systems, and free-flowing streams and creeks. The alteration of natural river systems has been both beneficial and detrimental to the bald eagle. While large portions of riparian forests were inundated, otherwise destroyed during construction of dams and other water developments, and damaged by controlled dam releases; the reservoirs created by these structures enhance habitat for waterfowl and fish species on which bald eagles prey.

Arizona bald eagles are considered distinct behaviorally from bald eagles in the remaining lower 48 states in that they frequently construct nests on cliffs. One study found that cliff nests were selected 73% of the time, while tree nests were selected 27% of the time. Additionally, eagles nesting on cliffs were found to be marginally more successful at reproducing. Bald eagles in the southwest are also unique in that they lay eggs in January or February, which is early compared with bald eagles in other areas. It is believed that this is a behavioral adaptation to allow chicks to avoid the extreme desert heat of midsummer. Young eagles will remain in the vicinity of the nest until June (Hunt *et al*. 1992).

Bald eagles in Arizona consume a diversity of food items, including some invertebrates. However, their primary food is fish, which are generally consumed twice as often as birds, and four times as often as mammals. Bald eagles are known to catch live prey, steal prey from other predators (especially osprey), and use carrion. Carrion constitutes a higher proportion of the diet for juveniles and subadults than for adult eagles. Diet varies depending on what species are available locally. This can be affected by the type of water system on which the breeding area is based (Hunt *et al*. 1992).

A recovery plan was developed for bald eagles in the southwest recovery region in 1982 (USFWS 1982). Goals of the recovery plan were to achieve an overall reproductive output of 10 to 12 young per year and to determine occupancy of one or more pairs on a drainage other than the Salt or Verde Rivers. These goals have been met, and the bald eagle was reclassified nationwide to threatened status. While bald eagles in the southwest were initially considered a distinct population, the final rule notes that the Service has determined that bald eagles in the southwestern recovery region are part of the same bald eagle population found in the remaining lower 48 states.

While the bald eagle has been reclassified to threatened, and although the status of the birds in the southwestern recovery region is on an upward trend, the population remains small and under threat from a variety of factors. Threats persist largely due to the proximity of bald eagle feeding areas to major human population centers. Additionally, because water is a scarce resource in the region, recreation is concentrated along available water courses. Some of the threats and disturbances to bald eagle include entanglement in monofilament fishing line and fishing hooks, overgrazing and related degradation of riparian vegetation, shooting, alteration of water systems for water distribution systems, maintenance of existing water development features such as dams or diversion structures, disturbance from recreation, and alteration of fish community structure due to species declines and nonnative species invasion (AGFD 2000a). The use of breeding area closures and close monitoring through the Bald Eagle Nestwatch program have been and will continue to be essential to the recovery of this species.

ENVIRONMENTAL BASELINE

A definition for environmental baseline was given in the biological opinion. The general degradation of the Gila River basin environmental baseline was also discussed. This overall loss of aquatic ecosystem and native fish community is a significant factor in consideration of the effects of nonnative aquatic species introduction and spread. Although that discussion was relatively comprehensive, the following information may assist in a more complete understanding of the highly degraded status of Gila basin native fishes and their habitats and the riparian species that are dependent upon that fish community.

EXISTING NONNATIVE SPECIES IN GILA RIVER BASIN

There are already 40 nonnative fish species known to be established and reproducing in the Gila River basin (Table 5). At least another 24 species have been reported from the basin but that did not become established or their status is unknown.

Table 5. Nonnative Aquatic Fish Reported from the Gila River Basin

Species Name	Established? Y=yes, N=no, U=unknown	ASU GIS Database of Fish	AGFD Database	Minckley 1973	Other Sources
Threadfin shad	Y	X	X	X	
Cutthroat trout	U	X	X	X	
Rainbow trout	Y	X	X	X	
Brook trout	Y	X	X	X	
Brown trout	Y	X	X	X	
Lake trout	N	X			
Kokanee	U		X	X	
Golden trout	N			X	
Arctic grayling	Y	X	X	X	
Northern pike	Y	X	X	X	
Common carp	Y	X	X	X	
Goldfish	Y	X	X	X	
Grass carp	N	X	X	X	

Table 5. Nonnative Aquatic Fish Reported from the Gila River Basin					
Species Name	Established? Y=yes, N=no, U=unknown	ASU GIS Database of Fish	AGFD Database	Minckley 1973	Other Sources
Silver carp	N	X			Marsh & Minckley 1983
Golden shiner	Y	X	X	X	
Red shiner	Y	X	X	X	
Beautiful shiner	N			X	
Central stoneroller	N	X			
Fathead minnow	Y	X	X	X	
Pacu	U				AGFD 2001a
Bigmouth buffalo	Y	X	X	X	
Black buffalo	Y	X		X	
Smallmouth buffalo	Y	X	X	X	
Rio Grande sucker	Y	X		X	Sublette *et al*. 1990
White sucker	U		X		Sublette *et al*. 1990
Flathead catfish	Y	X	X	X	
Channel catfish	Y	X	X	X	
Yaqui catfish	N	X			
Black bullhead	Y	X	X	X	
Yellow bullhead	Y	X	X	X	
Brown bullhead	Y	X	X		
Suckermouth catfish	N	X			
Mosquitofish	Y	X	X	X	
Variable platyfish	N			X	
Green swordtail	N			X	
Sailfin molly	Y	X	X	X	
Mexican (shortfin) molly	N	X		X	
Guppy	Y	X	X	X	

Table 5. Nonnative Aquatic Fish Reported from the Gila River Basin

Species Name	Established? Y=yes, N=no, U=unknown	ASU GIS Database of Fish	AGFD Database	Minckley 1973	Other Sources
Striped bass	Y	X	X		
White bass	Y	X	X	X	
Yellow bass	Y	X	X	X	
Smallmouth bass	Y	X	X	X	
Largemouth bass	Y	X	X	X	
Spotted bass	Y	X	X	X	
Warmouth	Y	X	X	X	
Green sunfish	Y	X	X	X	
Bluegill	Y	X	X	X	
Redear sunfish	Y	X	X	X	
Pumpkinseed	N	X		X	
Rockbass	Y	X	X	X	
White crappie	Y	X	X	X	
Black crappie	Y	X	X	X	
Sacramento perch	N			X	
Walleye	Y	X	X	X	
Yellow perch	N	X		X	
Oscar	N				Wright & Sorenson 1995
Convict cichlid	N			X	
Firemouth cichlid	N				Marsh & Minckley 1982
Rio Grande cichlid	N				Marsh & Minckley 1982
Mozambique mouthbrooder	Y	X		X	
Nile mouthbrooder	N			X	
Red-belly tilapia (*T. zillii*)	Y	X	X	X	

Table 5. Nonnative Aquatic Fish Reported from the Gila River Basin					
Species Name	Established? Y=yes, N=no, U=unknown	ASU GIS Database of Fish	AGFD Database	Minckley 1973	Other Sources
Blue tilapia	Y	X			
Longjaw mudsucker	N	X		X	

In addition to nonnative fish, a variety of other species have been introduced into the Gila River basin. Nonnative amphibians that are established include bullfrog, Rio Grande leopard frog, and tiger salamander (Clarkson and DeVos 1986, Platz *et al*. 1990, USGS 2001). The African clawed frog has also been recorded within the basin and there are concerns it may spread (AGFD unpub. data). Nonnative aquatic reptiles recorded from the Gila River basin include slider, spiny softshell turtle, western painted turtle, snapping turtle, alligator snapping turtle, American alligator, spectacled caiman, and water monitor (USGS 2001). Some of these are incidental releases of pets, but several of the turtles are established and reproducing (SWCA 1996, Degenhardt *et al*. 1999, AGFD 2001a).

There is little information on nonnative aquatic invertebrates in the Gila River basin. The ghost rams-horn snail is known from Pena Blanca Lake and possibly the San Pedro River (Bequaert and Miller 1973). Big-ear radix and Chinese mystery snail are also known to have been introduced into the Gila basin (Bequaert and Miller 1973). Asian clam are throughout large portions of the basin (Kubly and Landye 1984), a nonnative zooplankton has been documented from Salt River reservoirs (Plankton Ecology Group 1995), and a nonnative tubificid worm has also been found in those reservoirs and Salt River valley canals (Blinn and Cole 1991). The northern crayfish is found widely in the Gila River basin and the red swamp crayfish is found in the lower Gila River (Inman *et al*. 1998). A third species, the Everglades crayfish, is commonly found in aquarium stores.

Nonnative aquatic plants in the Gila River basin include water cress, dotted duckweed, Eurasian water-milfoil, curly pondweed, and yellow floating-heart (USGS 2001). Water cress is ubiquitous in the basin and has become a significant ecosystem component in many native fish areas (Minckley 1969, Lawson 1995). In addition, nonnative riparian plants can alter watershed and riparian functioning (Kunzmann and Johnson 1987). There are several nonnative riparian plants that have had significant impacts to the aquatic ecosystems of the Gila River basin, such as salt cedar, bermuda grass, yellow sweet clover, and rabbit's foot grass (Kerpez and Smith 1987, Stromberg and Chew 1997).

Nonnative pathogens are even more poorly documented than other nonnative aquatic species. Asian tapeworm recently invaded the Gila River basin and was found during CAP 1998 autumn sampling in the Gila River near Ashurst-Hayden dam (R.Clarkson, USBR, pers. comm. Nov.

1998). Anchor worm is a widespread fish parasite which probably originated in Asia and was spread through the trade in goldfish (Hoffman and Schubert 1984). Sixty-eight fish pathogens have been recorded from the Gila River basin (Hart 1999). Some of those are not native to the basin, although origin is somewhat difficult to determine due to lack of historic records.

SECTION 7 CONSULTATION ENVIRONMENTAL BASELINE

Two categories of section 7 consultations were discussed in the biological opinion that contribute to the degraded environmental baseline for this consultation. Table 6 shows those consultations that have been conducted on Federal actions that result in, or encourage, introduction and spread of nonnative aquatic species in the Gila River basin. The second category of consultations are those for the CAP. They are listed in Table 1 in the consultation history section of this document and in Appendix 3.

Table 6. Section 7 Consultations Addressing Nonnative Aquatic Species Concerns[1] Within the Action Area

Project	Date of Opinion	Species	Findings
FORMAL CONSULTATIONS			
Designation of roadless areas on USFS lands in AZ and NM	February 23, 1979	Apache trout Colorado squawfish Gila trout Gila topminnow woundfin Mexican wolf	nonjeopardy for all species
Central AZ Water Control Study, New Waddell element of Plan 6	Nov. 15, 1984 amended July 2, 1997	bald eagle	jeopardy
Central AZ Water Control Study, Cliff Dam element of Plan 6	August 15, 1985	bald eagle	jeopardy
Transportation and delivery of CAP water to the Gila River Basin in AZ and NM (excluding the Santa Cruz subbasin)	April 20, 1994 amended June 22, 1995 May 6, 1998 July 15, 1998 Jan. 13, 2000 June 30, 2000	spikedace loach minnow Gila topminnow razorback sucker Colorado squawfish desert pupfish bald eagle	jeopardy/adverse mod of ch jeopardy/adverse mod of ch jeopardy jeopardy/adverse mod of ch nonjeopardy nonjeopardy nonjeopardy
Stocking rainbow trout and channel catfish into lower Colorado River	July 1, 1994	razorback sucker bonytail chub	nonjeopardy for both species

Table 6. Section 7 Consultations Addressing Nonnative Aquatic Species Concerns[1] Within the Action Area

Project	Date of Opinion	Species	Findings
Stocking rainbow trout in Lakes Mead and Mohave	July 5, 1995	razorback sucker bonytail chub	nonjeopardy for both species
Safford District, BLM, livestock grazing program	September 26, 1997	spikedace loach minnow Gila topminnow razorback sucker desert pupfish bald eagle 9 other species	nonjeopardy nonjeopardy nonjeopardy nonjeopardy nonjeopardy not likely to adversely affect nonjeopardy or not likely to adversely affect
TASRI/Transportation & delivery of CAP water to Santa Cruz R. subbasin & potential to introduce & spread nonnative aquatic species	draft June 11, 1999	Gila topminnow	jeopardy
Ongoing and long-term grazing on the Coronado National Forest	July 29, 1999	Gila topminnow bald eagle 14 other species	nonjeopardy not likely to adversely affect nonjeopardy or not likely to adversely affect
INFORMAL CONSULTATIONS			
Rainbow trout stocking, San Francisco R., Trout, SA, & Romero Cks, NM	January 13, 1993	loach minnow	not likely to adversely affect
Rainbow trout stocking in upper Verde River	February 6, 1995	Gila trout Gila topminnow razorback sucker spikedace Colorado squawfish SW willow flycatcher	no effect for all species

Table 6. Section 7 Consultations Addressing Nonnative Aquatic Species Concerns[1] Within the Action Area

Project	Date of Opinion	Species	Findings
Stocking sportfish into waters in 90 locations in Arizona	October 31, 1995	razorback sucker humpback chub bonytail chub desert pupfish Gila topminnow Little Col. spinedace spikedace loach minnow Apache trout beautiful shiner Yaqui chub Yaqui catfish Yaqui topminnow	no effect for all species
Fish stocking in Little Colorado, Agua Fria, Salt and Verde River drainages	December 15, 1995	spikedace loach minnow razorback sucker Gila topminnow Colorado squawfish bonytail chub Apache trout Little Col. spinedace bald eagle	not likely to adversely affect for all species
San Xavier CAP-Link Pipeline	May 13, 1999	unspecified	consistent with 1994 CAP biological opinion
Stocking rainbow trout and roundtail chub into Rio Salado Town Lake	January 10, 2001	spikedace loach minnow Gila topminnow razorback sucker desert pupfish Colorado squawfish Gila chub Chiricahua leopard frog Yuma clapper rail SW willow flycatcher bald eagle cactus ferr. pygmy owl	not likely to adversely affect for all species

[1]This includes formal and informal consultations for projects with the potential to introduce or spread nonnative species. It does not include projects with potential to alter nonnative species status through changes to habitat conditions.

DIRECT AND INDIRECT EFFECTS OF THE ACTION

INTRODUCTION

> *Native fishes of the American West will not remain on earth without active management, and I argue forcefully that control of nonnative warmwater species is the single most important requirement for achieving that goal.* (Minckley 1991:145)

The operation of, and delivery of water by, CAP in the Gila River basin will result in the introduction and spread of nonnative aquatic species into and within the basin with serious adverse effects to the native fish community, including spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, and Apache trout, as well as other aquatic and riparian species, including the bald eagle. Introduction and invasion of nonnative species is widely recognized within the scientific and natural resource management communities as one of the most serious environmental problems facing us today (Elton 1958, MacDonald *et al*. 1986, Hegenveld 1989, Coblentz 1990, McKnight 1993, Simberloff *et al*. 1997, Claudi and Leach 2000) Unfortunately, it is also one of the least publicized environmental issues (McKnight 1993). This lack of recognition is particularly true for fish, which, because they are not easily seen or understood, have less public support (Allendorf 1988). The lack is even more pronounced for other aquatic species such as amphibians, invertebrates, algae, parasites, and diseases (Carlton 1989). However, partly in response to such economically costly introductions as the zebra mussel, there is increasing attention to the issue of nonnative aquatic species and their adverse, and generally irreversible, effects on native aquatic species and ecosystems (Courtenay and Stauffer 1984, Welcomme 1988, Rosenfield and Mann 1992, Aquatic Nuisance Species Task Force 1994).

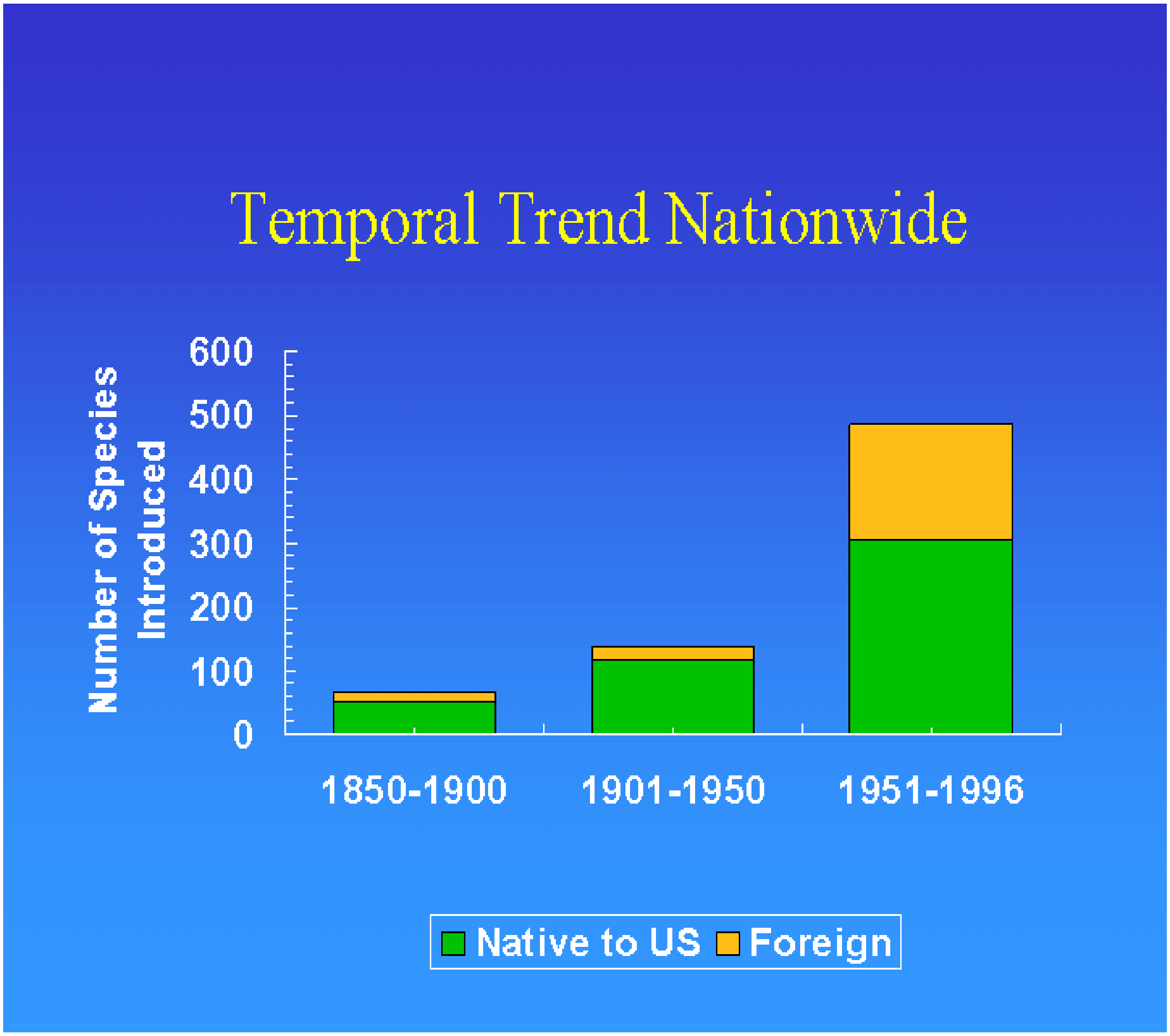
Throughout North America, the introduction and spread of nonnative aquatic species has been identified as one of the major factors in the continuing decline of native fishes and this is particularly so in the southwest (Miller 1961, Lachner *et al*. 1970, Ono *et al*. 1983, Carlson and Muth 1989, Cohen and Carlton 1995, Tyus and Saunders 2000). Miller *et al*. (1989) concluded that introduced nonnatives were a causal factor in 68% of the fish extinctions in North America in the last 100 years. For 70% of those fishes still extant, but considered to be endangered or threatened, introduced nonnatives species are a primary cause of the decline (Aquatic Nuisance Species Task Force 1994, Lassuy 1995). In the Gila River basin, introduction of nonnatives is considered a major factor in the decline of all 18 native fish species (Minckley 1985, Williams *et al*. 1985, Minckley and Deacon 1991).

Nonnative aquatic species have also been identified as a significant contributing factor in the decline of North American native amphibians (Bradford *et al*. 1993, Drost and Fellers 1996, Lawler *et al*. 1999, Knapp and Matthews 2000) although the problem appears to be more significant in western North America (Simberloff *et al*. 1997). In particular, nonnative species are considered a major factor in decline of several native amphibians of the Gila River basin, such as Chiricahua leopard frog, lowland leopard frog, and Sonora tiger salamander (Rosen *et al*. 1995, Fernandez and Rosen 1996, Sredl 1997, Collins and Snyder 2000). Similar effects to other aquatic species are also likely, although less well documented. Riparian dependent species, such as the bald eagle, are also affected (McClelland *et al.* 1983, AGFD 2000a, Li *et al*. 2000).

The number and distribution of nonnative aquatic species within the United States is increasing (Nico and Fuller 1999, USGS 2001) (Figure 1). Carlton (1992:13) points out that ". . . it is clear that the potential for exotic [=nonnative] species to continue to invade and restructure most aquatic systems in the 1990's is staggering." In Arizona, release or dispersal of new nonnative aquatic organisms is a continuing phenomenon. Despite the information available over the past decade regarding the serious consequences, there continue to be deliberate efforts to introduce new species. In 1987-91 the State of Utah proposed to introduce rainbow smelt, a native of the northeastern U.S., into Lake Powell on the Colorado River, but dropped the proposal due to substantial opposition (Utah Dept. of Natural Resources 1990). In 1997 CAWCD proposed to introduce black carp, a native of Asia, into the CAP aqueduct for the control of possible future invasions of zebra mussel (J. Garza, CAWCD, pers. comm., October 1997). And, since the mid 1990's, aquacultural use of pacu, a native of South America, has been licensed by the State of Arizona (Univ. of Arizona 1998). Pacu has now escaped into the wild and a trophy size angling record has been established for a pacu caught in Lake Pleasant, where CAP water is stored (AGFD 2001a).

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

Figure 1. Temporal Trend in Introduction of Nonnative Fish in the United States
(Taken from http://nas.er.usgs.gov/fishes/images)



"Native to US" includes species which are native to some portion of the United States, and which have been introduced into other areas of the United States that are outside of their historic range.

"Foreign" includes those species which are native to areas outside the United States, and which have been introduced into the United States.

“bait-bucket” transfer (T. McMahon, AGFD, pers. comm., 1998). Similarly, in the Verde River, the gradual upstream expansion of tilapia has moved over Bartlett Dam.

Achieving sufficient control and reduction of existing and future nonnative aquatic species in the Gila basin, will be difficult and expensive even without the CAP. Control of future invasions and reduction of existing nonnative populations is critical to the continued survival of all native Gila basin fishes, including spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout and Apache trout. It is also important to the long-term health of fish-eating birds, such as the bald eagle. With the CAP, the likelihood of achieving sufficient control and reduction to prevent serious loss or extinction of these species diminishes substantially.

THE REGULATORY FRAMEWORK

The role of the Endangered Species Act concerning prevention and control of nonnative aquatic species invasion is limited to effects to federally listed species. From a broader standpoint, there are three primary documents that directly address the Federal position on the nonnative issue and provide guidance for our analysis of the effects of the proposed action. The 1977 Executive Order 11987 on *Exotic Organisms* directs Federal agencies to “restrict the introduction of exotic [=nonnative] species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration;” and to “encourage the States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States.” The 1999 Executive Order 13112 on *Invasive Species* also directs Federal agencies to “prevent the introduction of invasive [=nonnative] species” and in addition to “detect and respond rapidly to and control populations of such species;” to “monitor invasive species populations;” to “provide for restoration of native species and habitat conditions in ecosystems that have been invaded;” to “conduct research on invasive species;” and to “promote public education on invasive species.”

The Nonindigenous Aquatic Species Prevention and Control Act of 1990 recognized the potential threat of adverse consequences of unintentional and intentional introductions of nonnative aquatic species and established an interagency Aquatic Nuisance Species Task Force to develop and implement a program for preventing introductions and dispersal of aquatic nuisance species. A 1994 report to Congress of the Task Force recommended that Federal agencies support education programs that enhance understanding of the nonnative species issues, support research on nonnative species impacts, closely examine any proposed new introductions, and not provide financial assistance for new introductions (Aquatic Nuisance Species Task Force 1994).

WHAT ARE NONNATIVE AQUATIC SPECIES?

The definition of a nonnative species is simple; it is a species that is outside of its historic range. The term nonnative species, as used in this document and the biological opinion, includes what are elsewhere called exotics, aliens, nonindigenous, introductions, and translocations. Exotics, aliens, and introductions are often terms used for species released into a country or continent other than the one of their origin. A translocated, transferred, or transplanted species generally refers to one released outside of its historic range, but on the continent of its origin, although it may also be one released into sites within its historic range. The definitions come from Lachner *et al*. (1970), Courtenay and Stauffer (1984), Shafland (1986), Soule (1990), Arthington (1991), and Aquatic Nuisance Species Task Force (1994). To simplify, we will refer to all of these as nonnatives, except for releases of species within historic range, which will be referred to as repatriation.

Nonnative aquatic organisms include a wide variety of plants and animals. The most obvious group with the best documentation are the fishes and because nonnative fishes have been demonstrated to be a significant problem to Gila basin native fishes and to the bald eagle, this analysis will lean heavily toward this group. However, aquatic and semi-aquatic mammals, reptiles, amphibians, crustaceans, molluscs (snails and clams), insects, zoo- and phytoplankton, parasites, disease organisms, algae, and aquatic and riparian vascular plants outside of their historic range have all been documented to adversely affect aquatic ecosystems (McKnight 1993, Cohen and Carlton 1995, USGS 2001).

WHAT SPECIES ARE LIKELY TO INVADE OR SPREAD VIA CAP AND WHERE WILL THEY COME FROM?

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

In general, species do not always use the same habitat and exhibit the same characteristics when placed into new surroundings, so preferences and tolerances of a species in its natural environment are not necessarily good predictors of the same in a new environment. In an area where it is not native, a species is often freed of predation, competition, and other constraints thus causing them to behave differently (Christie 1974, Ross 1994, Mack *et al*. 2000). In the presence of altered habitat, nonnatives may adapt to conditions previously thought unsuitable for them; i.e. "as an organism approaches the limit for one dimension, the limits may change for others" (Stauffer 1984). Species with a high degree of intrinsic variability that enables them to adapt to a wide variety of conditions are more likely to be successful colonizers (Laurenson and Hocutt 1985).

Even if one could reliably predict which species is likely to invade, the time frame of effects may not be easily predictable (Aron and Smith 1971). Some species rapidly multiply immediately upon invasion and immediately affect other species. Others invade and languish with virtually no population increase until a later time at which they explode (Christie 1974). During the lag phase it is difficult to distinguish the incidental, unsuccessful immigrant from the potentially serious problem (Mack *et al*. 2000). Courtenay (1993:56) states, "Because introduced species may not express an invasive nature beyond localized areas or negative impacts to native biota and habitat until years or decades following initial releases or ingress, every introduction must be viewed as a potential 'time bomb' waiting to explode in the future." This is an important principle in this analysis and taken together with the irreversibility of most introductions, leads to the conclusion that all introductions must be viewed as a potential problem and all measures possible taken to prevent them.

Nevertheless, some attempt to identify the species and their sources is necessary to an analysis of the potential for CAP to introduce and spread such species. Early studies on the potential of CAP to transfer nonnatives focused only on fish already present in the Colorado basin, and were limited to striped bass, white bass, blue tilapia, rainbow smelt, and grass carp (Matter 1991). Matter (1991) concluded at least some of these species would make it into natural waters of the Gila basin, but they would probably not have a great effect on listed fish there because of temperature, habitat size, and other limitations. Of those species, striped bass have now entered the Gila basin via CAP, white bass have used the CAP to move far to the south in the basin, blue tilapia have greatly increased their range in the basin via mainly bait bucket, rainbow smelt have not yet been introduced, and grass carp continue to be introduced into CAP and other water systems, but only as sterile triploids. But, although accurate so far, Matter's predictions may be altered by future changes in habitat conditions or species adaptations. For example, the University of Arizona has been attempting to breed tilapia with a higher level of cold tolerance for use in aquaculture (Univ. of Arizona 1993). The 1994 biological opinion concluded that, although the five species considered by Matter were of concern, there were many other species or groups of species of at least as great, if not greater, concern. Because the aquatic ecosystems of the central Gila basin and Santa Cruz subbasin have relatively small streams with warm water and low gradients, and because many of the native species are small, it is likely that much of the threat to native fishes will come from small nonnative fish species, as has also been noted for southern Nevada aquatic ecosystems (Deacon *et al*. 1964).

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

Concerns about nonnative aquatic species and CAP primarily stem from: 1) introduction of species from the Colorado River via the aqueduct; 2) spread of nonnative aquatic species already present in the Gila River basin into areas in which they are not previously found; 3) introduction and spread of nonnative aquatic species by unauthorized stocking or dumped into the aqueduct, connected, or CAP-created waters; and 4) spread of authorized stockings made into water bodies created with CAP water or water made available by CAP. These areas of concern have different nonnative aquatic species to contribute to the pool of potential species which may invade or spread within the Gila River basin due to CAP. Transport mechanisms for these species are discussed in later sections of this document.

Potential Species for Introduction from the Colorado River

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

When the 1994 biological opinion was written, we were only vaguely aware of a species called pacu. However, it was already common in the aquarium trade and already, or soon thereafter, being licensed for aquaculture use along the lower Gila River (Kevin Fitzsimmons, Univ. of AZ, pers. comm., April 2001; Univ. of Arizona 1998). By 1996, pacu were taken repeatedly in Lake Havasu, including nearby the CAP intake (C. Minckley, USFWS, pers. comm., 2001). By late 1999, pacu had appeared in Lake Pleasant (AGFD 2001a). Since pacu have not been recorded from the CAP aqueduct, it cannot be determined for certain whether they moved from Lake Havasu to Lake Pleasant via the CAP aqueduct or whether they were introduced into Lake Pleasant by an unauthorized release. However, it is possible that this was the second introduction of a new species into the Gila River basin via CAP.

Other nonnative fish species in the Colorado drainage that are not in the Gila basin include the redside shiner, plains killifish, and gizzard shad (Hughes 1981, Haynes *et al*. 1982, J.Brooks, USFS, pers. comm., June 2000). Invertebrates known from the Colorado River and basin that have not yet invaded the Gila basin, include the paper pondshell (U.S. National Museum catalog no. 892027) and the Oriental snail or red rim melania (Landye 1973). Red rim melania may also carry a fish parasite, a heterophyid trematode that is causing problems with listed fish in Texas (Fuller and Brandt 1997). A nonnative freshwater crab was recently reported from the Colorado River in a cove of Lake Mead (Cook in press, USGS 2001). The potential of its future survival and dispersal are unknown, but this new introduction is upstream of the CAP intake.

In 1999, a nonnative aquatic fern, giant salvinia was found in the mainstem of the lower Colorado River (Dahlberg 2000). A native of Brazil, this plant is a free-floating species that can rapidly cover large areas of open water in a thick mat. It is presently found in the wild in several states in the southeast, including Texas, and is found in nurseries and gardens in many more, including Arizona and California (USGS 2001). Because it breaks off into small floating pieces which can found new populations and because its leaves have hairs that allow the species to adhere to surfaces, it is highly invasive, spreads through stream and canal systems easily and quickly, and is transported on boats, equipment, animals, and humans (USGS 2001). Presently it is only found in the Colorado River near and below Blythe, which is downstream of the CAP intake. However, there are extensive marsh areas highly suitable for giant salvina just upstream from the CAP intake and if salvinia colonizes those areas, its transport by the CAP into waters in the Gila River basin is almost certain.

Potential Species for Spread Within the Gila River Basin

Distribution of nonnative aquatic species within the Gila River basin is highly variable. Some species, such as green sunfish, are ubiquitous, while others, such as threadfin shad, are confined to certain areas. To some extent, these distributions are determined by water temperature and habitat, but for some species their confinement to certain areas is determined, at least in part, by obstacles to successful emigration. The CAP removes some of those obstacles and offers enhanced opportunities for spread by linking many formerly fragmented portions of the Gila River basin (see later section on relationship to basin fragmentation).

Species which can live and reproduce in the aqueduct will have the greatest potential for use of the CAP system for spreading. In addition, if their populations in the aqueduct become substantial, they may provide sufficient augmentation of marginal populations in connected surface waters to support those at a much higher, and possibly more harmful, level. Other species, for which the aqueduct provides poor habitat, may use the aqueduct only as a passageway between more suitable habitats. Under that scenario the likelihood of successful movement would be small, but may still result in occasional spread of a species into new areas.

As of 1990, 17 species of fish (only 3 of which were native species), 3 invertebrates (2 of which may be native), 4 plants (3 of which were native), and a native algae were found in the CAP aqueduct (Table 5 of the biological opinion) (Mueller 1989, Mueller 1997). Of the 17 fish species, 5 were observed to be reproducing. Fourteen of the 17 were thought to have entered the aqueduct from the Colorado River and 2 of the natives were thought to have been bait-bucket introductions into the aqueduct. Monitoring since 1994, under the terms of the earlier reasonable and prudent alternative, documented continued presence of 11 of the species found in 1986-90 (Table 5 of the biological opinion), plus 3 additional nonnative fish species (Clarkson 1998, 1999, 2001). None of the fish found during the later monitoring were natives. Thirteen of the nonnative species found in the monitoring have moved through the aqueduct at least as far as the Brady pumping plant in the lower Santa Cruz subbasin.

The fish in the aqueduct (the only species group currently being monitored) have changed over time (Mueller 1997, Clarkson 1998) (see Table 5 of the biological opinion) and are expected to continue to change. Mueller found 17 fish species in the aqueduct between Lake Havasu and the Gila River; Clarkson found 9, plus another 5 between the Gila River and the aqueduct terminus (i.e. within the Santa Cruz subbasin). The 6 species found by Mueller, but not found by Clarkson, included 3 native species and all were rare in Mueller's surveys. Clarkson (1998) believed lack of capture of some of these species (e.g. mosquitofish) was possibly due to a reduced sampling effort compared to Mueller, but surmised that some may have disappeared from the aqueduct due to changes in system operation and water velocities. Changes in the fish community will occur as water transport rates increase and summer water temperatures decrease due to hypolimnal releases from Lake Pleasant (Clarkson 1998).

Several fish species that have been confined to only a portion of the Gila River basin could potentially use CAP connections to spread into other areas of the basin. White bass, which was only in Lake Pleasant in the Gila basin at the time CAP began pumping, has now found its way along the aqueduct to the Brady pumping plant in the lower Santa Cruz subbasin (Matter 1991, Clarkson 1998). This greatly increases the opportunities available to white bass to colonize new areas of the Gila basin. Tilapia, which are now present in Lake Pleasant as well as other areas of the Gila basin (AGFD unpub. data), are not yet found in the Gila River above Ashurst-Hayden dam (Clarkson 1999, Marsh 1999, Bettaso 2000). Although they have not been found in the CAP aqueduct, they may under some circumstances use it to move from one part of the Gila basin to another. Golden shiner, which are found in only a few places in the Gila basin including Picacho Reservoir (SWCA 1996), may use the Florence-Casa Grande Canal and its connection to the CAP aqueduct to move into other parts of the Gila basin.

The nonnative Rio Grande leopard frog has become established and has been rapidly spreading within the lower Colorado River south of Laguna Dam and the lower Gila River. This species was apparently introduced into the lower Gila or Colorado Rivers near Yuma in the late 1960's or early 1970's as an incidental inclusion in shipment of sport fish from either Uvalde, Texas or Dexter, New Mexico (Platz *et al*. 1990). It has now spread upstream in the Gila River as far as the Agua Fria River and up the Agua Fria to near Lake Pleasant. It has also spread through about 50 miles (80 kilometers) of desert in the All-American Canal into, and throughout, the Imperial Valley of California (Rorabaugh *et al*. in review). Although the concrete lined CAP will not provide good habitat for this species, it is likely that Rio Grande leopard frogs will at least occasionally use the aqueduct as part of a route of transportation to new areas. The establishment of water bodies using CAP water that will act as staging areas in spread, such as the Agua Fria Recharge area and Rio Salado Town Lake, may substantially increase the ability of such species to spread. Nonnative bullfrogs may also use some of the water connections established by CAP to spread to additional, presently unoccupied, areas.

The nonnative Asian clam is found in the lower Gila basin and in the Agua Fria, Salt and Verde River subbasins (Rinne 1974, Minckley 1979, Kubly and Landye 1984, Marsh 1985, USGS 2001). In 1984, it was not found in the Gila River above Ashurst-Hayden Dam or in the Florence-Casa Grande Canal (Kubly and Landye 1984) and was not recorded from Picacho Reservoir in 1995-96 (SWCA, Inc.1996). It has also not been recorded from the Santa Cruz River subbasin (Counts 1991, Lawson 1995; R. Wong, pers. comm., 1998; R. Wahl, Entranco, pers. comm., 1998; J. Landye, USFWS, pers. comm., 1998; USFWS unpub. data). The Asian clam was imported into the northwestern United States from where it spread rapidly through much of the country and was first recorded in Arizona in canals in the Phoenix area in 1952 (Counts 1986, Devick 1991, Rinne 1974, McMahon 1982). It is common in the CAP aqueduct (Mueller 1989, E. Holler, USBR, pers. comm., August 1998). Because deliveries of untreated CAP water have already been made to the Santa Cruz subbasin, and because the Asian clam has very high downstream mobility as a veliger (larva) and cannot be removed by normal screening methods, it is likely the clam has either already been transported into the Santa Cruz subbasin and if it has not, it soon will be. Although Asian clam cannot by itself move upstream, it has a long history of upstream migration presumably via human and other animal transport (Sinclair and Isom 1963). These abilities make it likely to use the CAP system as a route into other parts of the Gila River basin.

The red swamp crayfish is present in the lower Gila River and in the Colorado River upstream to Hoover Dam, including the vicinity of the CAP intake at Lake Havasu (Marsh 1997, P. Marsh, ASU, pers. comm., 1998). The red swamp crayfish, a native of the Mississippi basin, is a serious pest in many places in the United States and throughout the world (Welcomme 1988, USGS 1998). As the CAP aqueduct develops a layer of debris over the concrete bottom, it is likely this invasive species will begin to use the aqueduct and CAP created water bodies for transport and staging further into the Gila basin and the Santa Cruz subbasin.

A nonnative zooplankton (*Daphnia lumholtzi*) has been documented from reservoirs on the Salt and Verde Rivers (Plankton Ecology Group 1995). This zooplankton, which originated in Africa and Asia, has had adverse effects on other zooplankton and possibly fish populations in Arizona reservoirs (Plankton Ecology Group 1995, USGS 2001). Because it is a species of still waters, it is not likely to colonize the CAP aqueduct or most native fish habitats in the Santa Cruz subbasin. A nonnative tubificid worm (*Branchiura sowerbyi*) has also been documented from one of the Salt River reservoirs (Saguaro) and from canals in the Phoenix area (Blinn and Cole 1991). Undoubtedly there are other nonnative invertebrate species within the Gila basin that may use CAP and CAP connected waters as a conduit.

The Asian tapeworm is present in the Colorado basin in the Virgin River (Heckmann *et al*. 1986) and the Little Colorado River (Clarkson *et al*. 1997). It has recently invaded the Gila basin and was found during the CAP autumn 1998 monitoring in the Gila River below Ashurst-Hayden Dam (R. Clarkson, USBR, pers. comm., Nov. 1998). It is also present in the upper Rio Yaqui basin in Arizona on the San Bernardino National Wildlife Refuge, where it has infested the Yaqui topminnow and other native fish (USFWS 1997). This parasite, which is thought to have been introduced into the United States in grass carp, can infest many species of fish and is carried into new areas along with nonnative fishes or native fishes from contaminated areas. It was introduced into the Virgin River about 1984 in invading red shiner (Heckmann *et al*. 1986). The mechanism of Asian tapeworm invasion into the Gila River is unknown, but the tapeworm was found in both carp and red shiner. Its presence in the central Gila basin increases the likelihood of its spread into throughout the basin, and the movement of fish that will occur through the CAP aqueduct and connected waters will likely enhance the spread of Asian tapeworm in the Gila River basin.

Chytrid fungus (chytridiomycosis) has been spreading throughout amphibian populations in the Gila River basin (Sredl 2000). Efforts are being made to prevent or slow this spread, which can occur when zoospores move through water or through transport via wet or muddy equipment. Because of almost nonexistent baseline information, it is unsure if chytrid fungus is nonnative to the Gila basin or if it was always present and has only recently become prominent due to other factors affecting amphibian populations. Any movement of water, humans, animals, plants, or equipment between areas of the basin have the potential to enhance the spread of this fungus. CAP may assist in that spread.

Potential Species for Introduction and Spread by Unauthorized Dumping or Stocking into the CAP Aqueduct and Connected Waters

The nonnative aquatic species most frequently introduced by unauthorized stocking are sport fish, bait fish, ornamental, aquaculture, or pet species The mechanism for these will be discussed in more detail later.

The sport fish group is a relatively small group, as are the legal bait fish. However, both groups carry with them the potential for misidentification and accidental inclusion of other species. The AGFD maintains angling size records for 37 species of fish, all of which are part of those in Table 5 except the seven which are native; Apache trout, desert sucker, Sonora sucker, razorback sucker, roundtail chub, striped mullet, and Pacific tenpounder. Legal bait fish in the Gila River basin are limited to red shiner, threadfin shad, mosquitofish, fathead minnow, carp, all sunfish, plus in the lowermost parts of the Gila River, tilapia, golden shiner, and goldfish (AGFD 2001a). However, it is common for shipments or sales of bait fish to include additional species that are not legal bait (Ludwig and Leitch 1996). In addition, bait fish may introduce parasites and diseases into new areas (Goodchild 2000).

An example of unauthorized sport fish stocking is the recent introduction of northern pike into Parker Canyon Lake in southeastern Arizona (Graham 2000). The CAP aqueduct itself has been the recipient of unauthorized stocking of sport and other fish. Mueller (1988) reported that local workers had released goldfish and largemouth bass into the aqueduct.   All other sport fish presently found in the state are candidates for such unauthorized movements. In addition, sport species or hatchery-produced variants not presently in the state may be stocked by the public or workers into the aqueduct, or more likely into CAP fed water bodies such as in-channel recharge pools or recreational lakes.

Possible species that might enter the CAP system through unauthorized release or escape of aquaculture species is also not lengthy. However, new species are being added to the aquaculture industry regularly. Species presently licensed for aquaculture in the Gila basin include fathead minnow, golden shiner, Gila chub, black crappie, bluegill, redear sunfish, largemouth bass, striped bass, “wild local bass”, black bullhead, channel catfish, blue catfish, mosquitofish, koi, common carp, grass carp, goldfish, rainbow trout, brown trout, blue tilapia, Mozambique tilapia, Nile tilapia, redbelly tilapia, Wami tilapia, spotted metynnis or silverdollar, pacu, Louisiana crawfish, giant freshwater prawn, freshwater shrimp, brackish water shrimp, “wild local frogs”, “wild local turtles,” waterdogs, and unnamed “ornamental tropical fish” (Univ. of Arizona 2001).

Possible species that might enter the CAP system through unauthorized release or escape of ornamental or pet species is almost endless. Hundreds of species of freshwater fishes, amphibians, reptiles, crabs, crayfish, snails, other invertebrates, and plants are cultured, shipped, and sold for aquaria and pets. Families of fish containing small species that are thought to have particular likelihood to successfully invade the Gila basin include Cichlidae, Poeciliidae, Characidae, Gobiidae, Loricariidae, and Cobitidae. Many of the smaller members of the family Cyprinidae, to which the majority of the Gila basin native fish belong, are also considered to pose substantial threat. Small species such as these make up the bulk of the freshwater aquaria fishes.

Potential Species for Intentional Introduction and Spread from CAP Created Waters

In addition to nonnative aquatic species that may be unintentionally, or without authorization, stocked into the CAP aqueduct or into water bodies created by CAP or CAP in-lieu water, there may be a number of species intentionally introduced into these waters over the next 100 years. As discussed earlier, these species may be stocked for a variety of reasons. Grass carp and mosquitofish have already been intentionally stocked into the CAP aqueduct and black carp have been proposed for stocking in the aqueduct (see later section on releases for biological control). At present, grass carp in the CAP canal are sterile and are under careful control (CAWCD 2001a). The same species are likely to be stocked into other CAP related water bodies for vegetation and insect control. Control there may be less careful or may not prove effective, such as the repeated movement of grass carp over the electric barriers on the Salt River Project Canals near their CAP interconnection (USBR 2001). Substantial concern has surfaced regarding mosquitos in constructed wetlands and recharge projects (Hart 1997, Karpiscak *et al*. 1999) and nonnative fish are often stocked to alleviate those concerns. Other water bodies using CAP water may be intentionally stocked with sport or ornamental fish. Koi and goldfish are often stocked into recreational lakes. Rio Salado Town Lake was recently stocked with native roundtail chub and nonnative rainbow trout, for sport fishing purposes.

THE ROLE OF TIME IN EFFECTS FROM THE PROPOSED ACTION

An understanding of the long duration of the project is very important in assessing effects of CAP to Gila basin native fishes and riparian species. The expected project life for the CAP aqueduct is 100 years, during which substantial changes will occur in the project, the ecosystem, available technology, and water use. For example, water sources, use, and development in Arizona 100 years ago was substantially different from today. In 1893, none of the dams on the Salt and Verde Rivers, that supply much of the water to the Phoenix metropolitan area, even existed. Now there are two major dams on the Verde and four on the Salt River. In 1883, Phoenix was one of several small towns scattered along the Salt River valley. It is now a megalopolis of 1.3 million people (ADES 2001). Changes of a similar or greater magnitude can be expected between 1993 and 2093 — the project life of the CAP — and will greatly influence the likelihood and routes by which nonnative aquatic species are introduced and spread by CAP.

Effects that have a small probability of occurring in any one year, have a greater probability of occurring when the project spans many years. The 100-year time span of the CAP means that even low probability effects have a good chance of happening at least once, and potentially many times. Effects that have a moderate probability of occurring in any given year, are almost certain to occur during a project with a long time frame. For example, Ludwig and Leitch (1996) calculated the probability of bait-bucket transfers of fish occurring from the Hudson Bay basin to the Mississippi River basin. The likelihood of a single angler on a single day releasing bait fish was only 0.0117 (1.2%). However, over a year with 19 million angler days (see Ludwig and Leitch 1996 for explanation of how angler days were calculated for this analysis) the probability of not just one, but up to 10,000, successful releases of bait fishes rises to 0.996 (99.6%), or virtual certainty. Similarly, the probability of CAP successfully introducing or providing the means of dispersal for a given nonnative species on any given day at any given location, is small. However, over the anticipated 280-350 water delivery-days per year, and given multiple species and multiple dispersal routes, the probability rises rapidly, becoming certainty well before reaching the 100-year project life.

UNCERTAINTIES AND UNDERLYING ASSUMPTIONS AND CONCEPTS OF THE ANALYSIS AND CONSERVATION MEASURES

There are many uncertainties regarding operation of the CAP, both now and throughout the 100-year project life, including where and to whom CAP water will be delivered, the mechanisms of delivery, how the water will be used, etc. Substantial changes in water use and demand in the southwest are expected during the next 100 years (Unruh and Liverman 1997). Over that 100 years many changes in CAP operation and water uses are also expected; agricultural practices will change and probably decrease, turnout locations may change or increase, recharge technology will change or recharge may be replaced by other water saving mechanisms, municipal water use will increase, water conservation and recycling technology will change, and so on. In addition, there are even more uncertainties regarding the ecosystem and invading nonnatives, including what nonnative aquatic organisms will successfully invade, what mechanism and route nonnatives will come through, how a particular nonnative species will behave and adapt to the Gila basin ecosystem, what climatic, biotic, and abiotic conditions will exist at the time of invasion, and how hydrologic and biologic conditions will change over time.

These uncertainties and changes expected over the long project life, plus information from other interbasin water transfer projects (see Interbasin Water Transfer section, below), lead the Service to believe it would not be prudent or scientifically sound to base analysis of potential effects of the proposed project on a site-by-site consideration of present biotic and abiotic conditions along CAP and within the Gila River basin for a selected subset of nonnative species, as has been advocated by some applicants. Such a short-term, limited scope, analysis would result in an emphasis on near-term details while failing to perceive the larger, long-term picture and would likely require frequent and extensive reconsultation as project and ecosystem specifics varied over time. Unless severely limited to consideration of only a few species, such as in Matter

1991, that type of analysis would also require an inordinate expenditure of time and effort and would greatly increase the size of the documentation needed for this consultation with no corresponding increase in quality or confidence of analysis. Consequently, this analysis emphasizes existing data on predicted and documented effects of similar interbasin water transfer projects, including data on movement of species already occurring through the CAP aqueduct. In addition, we assessed the information on existing specifics of CAP and the Gila River aquatic ecosystem to determine if CAP is, and would remain, sufficiently similar to other interbasin water transfers to validate use of the body of data from those experiences as a predictor of the consequences that can be expected from water transfer via CAP.

In formulation of the reasonable and prudent alternative of the 1994 biological opinion two important underlying concepts were used. Because the conservation measures are based, for the most part, on the 1994 reasonable and prudent alternative, these concepts continue to be important. These concepts were also the basis for that portion of the conservation measures that goes beyond the 1994 reasonable and prudent alternative.

The first of these concepts has been characterized as the “last ditch stand at the bottom of the native fish habitats.” As described in the consultation history section of this document, the 1991-94 consultation started with the concept of a multi-tiered protection system that would first work to keep the nonnative species from entering the CAP aqueduct; then if they did enter, to keep them from leaving the aqueduct and entering the Gila River basin; then if they did leave, to keep them from getting into the native fish habitats. Because of technical and economic feasibility concerns, the multi-tiered approach was dropped tier by tier until protection measures were focused on keeping the invading nonnatives out of the native fish habitats. That “last ditch stand” concept provides a basis for refocusing attention on occupied and recovery habitats of the native fishes rather than on interdiction of CAP introduced and spread nonnative species lower down in the system. Under this concept, the bulk of the resources for mitigation of CAP nonnative threats are to be placed at locations that maximize benefits to existing and potential repatriated populations of the listed fish species. As a result, the six additional barriers proposed as part of the conservation measures are located at the lower end of important native fish habitats. But, in accepting the “last ditch stand” concept, it is also accepted that there will be only partial exclusion of CAP introduced or spread nonnatives from the Gila River itself and that the spikedace and loach minnow habitat in the middle Gila River below Coolidge Dam will not receive full protection.

The second concept is that recovery actions to improve the status of the species can be used to compensate for the substantial portion of the threat from CAP introduced and spread nonnative aquatic species that cannot feasibly be removed or ameliorated. This “recovery in-lieu of threat removal” concept is basic to both the 1994 reasonable and prudent alternative and to the present proposed conservation measures. The concept allows for conservation actions that may deal with other locations and other nonnative species that are not directly tied to the threat from the CAP and avoids the need to try to determine which nonnative species actually invaded or spread via

CAP. Such determinations are extremely difficult, and often impossible, and would require large expenditure of resources that could be better spent on actions that benefit the listed species. Because the recovery and nonnative management measures that will be carried out under this concept have varying probabilities of success, the compensatory in-lieu recovery must be greater than the potential loss due to the unmitigated threat.

THE RELATIONSHIP OF CAP TO BASIN FRAGMENTATION

Like most interbasin water transfers, CAP provides aquatic passage between previously separated areas of aquatic habitat. While CAP does not connect distinct basins, like the Tenn-Tom Waterway which connects the Mississippi basin with Mobile Bay, it does connect subbasins within the lower Colorado River basin (i.e. the Gila and Colorado Rivers) and subbasins within the Gila River basin (e.g. the Agua Fria and San Pedro Rivers). These connections are particularly significant in light of changes in aquatic ecosystems in those subbasins within the past century and a half. Prior to the advent of European settlement, the subbasins of the lower Colorado and Gila Rivers were connected much of the time by perennial water (Tellman *et al*. 1997). There was substantial opportunity for fish and other aquatic species to move among subbasins. But, beginning in the mid to late 1800's, connections between subbasins were severed by dewatering, dams, and habitat modifications (Dobyns 1981, Rea 1983). These disconnections made aquatic species movement between subbasins difficult and contributed substantially to declines in all of the native fishes of the lower Colorado basin (Hendrickson and Minckley 1984, Minckley 1985). However, there was some benefit to this fragmentation in that nonnative aquatic species introduced by Europeans, starting with carp in 1885, also found it difficult to move between portions of the basin. The CAP aqueduct is now reestablishing water connections between those subbasins. Because of the severely reduced range and depleted condition of most native fishes and the highly degraded habitat conditions in most of the central Gila basin, the new connections are unlikely to benefit native fish species. They will however, provide greatly enhanced opportunities for nonnative aquatic species to move between portions of the basin, particularly for those species tolerant of a wide range of habitat conditions.

MECHANISMS OF AQUATIC NONNATIVE DISPERSAL

Aquatic nonnative species are introduced and spread into new areas through a variety of mechanisms, intentional and accidental, and authorized and unauthorized (Fuller *et al*. 1999, Claudi and Leach 2000). Figure 3 of the biological opinion shows the relative role of various introduction mechanisms for past introductions of fish in the United States (USGS 2001). Mechanisms important for nonnative dispersal in the western United States which are related to CAP include interbasin water transfers, sport stocking, aquaculture, aquarium releases, bait-bucket release, and biological control.

Interbasin Water Transfers

The primary and overarching mechanism by which CAP will introduce and spread nonnative aquatic species in the Gila River basin is through interbasin water transfer (part of the 2.5% categorized as "miscellaneous" in Figure 3 of biological opinion). Although the proportional contribution of interbasin water transfers to total introductions of nonnative aquatic species in the United States is overshadowed by that of other mechanisms, interbasin water transfers not only directly introduce nonnative species, but are also an enabling mechanism for species introduced by other mechanisms, such as sport stocking, aquarium and aquaculture releases, bait bucket-releases, and biological control. For the purposes of this biological opinion, we follow the definition of interbasin water transfers of Davies *et al*. (1992:327); "the transfer of water from one geographically distinct river catchment or basin to another, or from one river reach to another." Thus, we include CAP transfers not only from the Colorado River to the Gila River, but among the Hassayampa, Agua Fria, Gila, Verde, Salt, and San Pedro Rivers, as well as transfers within parts of each of those subbasins.

Interbasin water transfers play a significant role in moving aquatic species between drainages (Petitjean and Davies1988, Davies *et al*. 1992, Meador 1992 and 1996, Stefferud and Meador 1998, Mills *et al*. 2000) as well as causing a suite of other ecological changes (Thomas and Box 1969, Stanford and Ward 1972). Table 4 in the biological opinion gives a selection of cases where movement of nonnative aquatic species from one drainage to another via interbasin water transfer has been documented. As shown in Table 4, at least 56 different aquatic species are believed to have been introduced into new areas by interbasin water transfers in North America. These are concentrated in the Great Lakes area where the density of such projects is high, but also include the southeast and western United States. In addition, interbasin water transfer projects in the England, Spain, Europe, Russia, South Africa, Panama, and Egypt have been reported to have resulted in new species introductions.

The known instances of movement of species through interbasin connections probably represent only a small portion of those that have actually occurred (Mills *et al*. 2000). Many species transfers through interbasin connections are not documented due to lack of, or inadequate, monitoring after the interbasin projects are put into operation (e.g. Tenn-Tom Waterway, California State Water Project). Other transfers may have been observed, but the data are in agency and organization files and are not generally available (e.g. various interbasin canals in Florida). Often, species movements through interbasin water transfers is inferred from the appearance of a species from one waterway in the other where it was not previously found, such as our earlier speculation on the role of CAP in the transfer of pacu from Lake Havasu to Lake Pleasant. If other mechanisms are also at work, such as purposeful stocking for sport fishing or unauthorized bait-bucket transfers by the public, it can be difficult to distinguish what mechanism actually resulted in transfer of the species, particularly as time passes after the initial connection.

There is also often a time-lag between opening of the interbasin connection and the movement of species (Aron and Smith 1971). The transfer of alewife into the Great Lakes from the Hudson

River was first noted 54 years after opening of the canal. Thus, the cause-effect relationship between interbasin transfer and species movement is often obscured; monitoring is suspended too early to detect movements; and predictions that such transfers will occur are dismissed before they can be documented. Because of these difficulties in documentation, it is likely that movement of aquatic species through interbasin transfers occurs at an even higher rate than recorded (Mills *et al*. 2000).

Nothing about CAP indicates it is sufficiently different from other interbasin water transfers to support a presumption that CAP would not fit into the general pattern illustrated in Table 4 (see biological opinion). Indeed, the predictions of Grabowski *et al*. (1984) regarding the potential for CAP to introduce and spread nonnative fish have been validated by actual data demonstrating that fish have moved through the intake pumps from the Colorado River into the CAP aqueduct and fish from that and other sources have colonized the aqueduct (Mueller 1989, Liston and Christensen 1995, Mueller 1997, Clarkson 1998,1999, and 2001). In addition to surviving the passage through the pumping plant at the intake, striped bass have safely passed through 3 other pumping plants, 3 tunnels, and 7 major inverted siphons between the intake and the Agua Fria River to reach Lake Pleasant on that river (AGFD 1993) making it the first new nonnative aquatic species documented to reach the Gila basin via CAP. Pacu may have also made that trip successfully. White bass have moved from Lake Pleasant through the aqueduct at least as far as the Brady pumping plant in the lower Santa Cruz subbasin, and 12 other nonnative fish species have found their way along the entire length of the aqueduct.

The aquatic "highway" that is the CAP aqueduct has obstructions inhibiting movement of species through the system. Among these are the intake pump at the Colorado River, 16 pumping plants along the length of the aqueduct, 3 tunnels (one of which is 7.5 miles [12 kilometers] long), and 9 major inverted siphons. These obstacles may inhibit, but do not prevent, aquatic species movement throughout the complete extent of the aqueduct and Lake Pleasant, as has been discussed above. Mueller (1989) documented that most of the movement of fish from the Colorado River through the intake pumping plant into the aqueduct was in the form of entrained eggs and larvae, however, he found that fish at least as large as 50 cm (20 in) in length could successfully survive the intake.

There are also a variety of obstacles to movement of species between the CAP aqueduct and other waters (CAWCD 1995). These obstacles will vary greatly over the 100-year life of the project, but at present include high pressure areas, high velocity areas, screens, pumps, steep gradients, long pipelines, irrigated fields, muddy canals, low oxygen sumps, filters, chlorination plants, and others. The efficacy of such obstacles at preventing nonnative movement (including seeds, eggs, and pathogens) range from almost certainty for chlorination to very low for muddy canals. Of course, the ability of species to move through such obstacles varies greatly; a seed can move through most screens but cannot move upstream against current, while a particular species of fish may be able to move upstream against substantial velocity but may not be able to withstand more than a short stay in a low-oxygen environment like an irrigation sump.

Species that survive obstacles of the CAP aqueduct may find themselves in irrigation canals, flooded fields, irrigation water sumps, recharge ponds, created wetlands, and recreational lakes. While many species would not survive these conditions, some potentially invasive species are well adapted to survival in, for example, irrigated fields, rice paddies, and sumps, such as the swamp eel, an eastern Asian native that has now been successfully introduced into Hawaii (Welcomme 1988), Georgia, and Florida (American Fisheries Society 1998). Lessons from other interbasin transfers indicate that species movement may occur despite what may seem to be overwhelming obstacles. Species moving through the Orange-Fish River Tunnel in South Africa must successfully negotiate a steep gradient tunnel with an intake mesh of 2.5 inches (6.5 centimeters) and interior velocity-damping baffles. Upon exiting the tunnel any surviving individual passes through a "pepper pot valve" in which the water is sprayed through small ports against concrete walls of the chambers at high pressure (Laurenson and Hocutt 1985). Despite that, at least four species of fish are known to have successfully made the transfer. In the River Stour in England, fish arrived from the Great Ouse despite passage through high pressure pipes and an 0.3 inch (8 millimeter) mesh screen (Guiver 1976). The California aqueduct system has obstacles similar to the CAP system and has still allowed at least nine fish species and one invertebrate to pass from the central and northern California drainages to southern California coastal drainages (Swift *et al*. 1993, Mills *et al.* 2000).

Sport Stocking

Most nonnative fish in the past in the United States have been stocked for sport fishing (44%), however introductions via this mechanism have declined substantially (Dill and Cordone 1997) and some states, including Arizona, have prohibited introduction of new species for sport purposes (Aquatic Nuisance Species Task Force 1994, Rinne and Janisch 1995). Although augmentation stockings of sport fishes continue in Arizona, there are efforts underway to ensure the adverse effects of these stockings on listed species are minimized or eliminated. However, there will continue to be a connection between CAP and sport fish stockings. Species introduced for sport purposes will use the CAP aqueduct to expand their range, as has already occurred with the striped bass.

A secondary aspect of the sport stocking mechanism is stocking of species to support other species stocked for sport fishing. This usually involves stocking small fish for forage by predatory sport fish (Courtenay 1993), but can also include invertebrates introduced for forage, such as crayfish and in some cases mayflies (Blinn and Cole 1991, Rinne and Janisch 1995). The CAP aqueduct provides an avenue for spread of these species and over the 100-year project life, some will undoubtedly use that avenue to expand their range beyond the site of their stocking.

In addition to these purposeful introductions for sport purposes, other species are often unintentionally introduced as misidentified or accidental inclusions in shipments of sport or bait fish. Gizzard shad were recently introduced to the Colorado River basin through accidental inclusion in a Service shipment of largemouth bass into the San Juan subbasin in 1999 (J. Brooks, USFWS, pers. comm., June 2000). Rio Grande leopard frog were introduced into the Colorado River in the late 1960's or early 1970's as an accidental inclusion in a shipment of sport fish (Platz *et al*. 1990).

Aquaculture and Aquarium Releases

Introductions of nonnatives through aquaculture and the aquarium trade are considered together because they are closely interrelated and sometimes cannot be distinguished. Aquatic species are cultured for a variety of reasons including food, aquarium trade, bait fish trade, sport, and research. Aquarium and aquaculture releases account for only 26% of the past nonnative fish introductions in the United States (Figure 3 in the biological opinion). However, both are rapidly growing areas of new species introductions, particularly in the warmer areas of the United States, like Florida and Arizona (McCann *et al*. 1996, AGFD unpub. data) and they are increasingly becoming the major mechanism for nonnative introductions (Courtenay 1993, Crossman and Cudmore 2000, Mackie 2000). The role of the aquarium and aquaculture mechanism in the United States can be expected to change to reflect the worldwide situation, where aquaculture and aquarium trade is the primary mechanism for fish and aquatic invertebrate introductions (Welcomme 1988, FAO 1998). It is estimated that over 100 million individual fish are imported by air into the United States annually for the aquarium trade, which is particularly astounding because that figure represents only about 20% of the individual fish placed into the aquarium trade each year in the United States (Courtenay 1993).

Approximately 65% of the fishes established in the United States from foreign countries are known or believed to have escaped from aquarium culture facilities or to be stocked by hobbyists (Courtenay 1993). Red shiner, a highly competitive fish, first arrived in the lower Colorado River basin when they escaped from a fish farm (Hubbs 1954) and have also been introduced into North Carolina through aquarium release (Moore *et al*. 1976). Blue tilapia became established in Pennsylvania (Skinner 1984, 1986, Stauffer *et al*. 1988, Courtenay and Williams 1992) and Texas (Howells 1992) after escaping from aquaculture facilities. Sailfin molly, now an inhabitant of the central and lower Gila basin, was apparently introduced directly into canals of the lower Salt and Verde Rivers about 1950, in an attempt to develop a harvestable population for the aquarium trade (Minckley 1973). Tropical fishes used in the aquarium trade are frequently found in canals in the Gila basin and in springs in the southwest, and may be escapees from aquarium or aquaculture facilities or discarded pets (Deacon *et al*. 1964, Marsh and Minckley 1982). Aquaculture and the aquarium trade are increasingly involved in the spread of nonnative crayfish (Lodge *et al*. 2000).

Pacu, which may have arrived at Lake Pleasant from Lake Havasu via the CAP aqueduct, are also a common aquarium release in Arizona. They are found yearly in a lake at the Phoenix Zoo. According to a former curator at the Zoo, during his 5 years there, he received an average of one call a week from pacu owners who were trying to find a home for fish that had grown too large for their aquarium (M. Demlong, AGFD, pers. comm., April 2001). Released pacu have been found in several urban lakes in the Phoenix and Tucson areas (AGFD and Univ. of AZ, unpub. data).

When vertebrate and invertebrate species are introduced into the ecosystem through aquaculture or aquarium trade, any parasites or diseases associated with these species are also introduced (Lightner *et al*. 1992, Ganzhorn *et al*. 1992). This may also occur with species stocked for sport fishing or fish introduced through bait use or by bait-bucket introductions.

There are presently 39 entities licensed by the Arizona Department of Agriculture to raise species in the Gila River basin for fish farming, fee fishing, or research (Univ. of Arizona 2001). The species licensed for culture at these facilities are listed earlier under the discussion of what species might be introduced or spread via CAP. All are nonnative species. Use of CAP water for aquaculture facilities has been proposed on the Pascua Yaqui Nation near Tucson (USBR 1994) and at the Gila River Indian Community near Sacaton (G.Brooks, GRIC, pers. comm. August 1999). Aquaculture on Tribal lands is not regulated by the State and there are at present no restrictions on what species could be cultured in such a facility. Other aquaculture facilities may use CAP water now and in the future. Such use would give CAP a direct role in the increased likelihood of nonnative aquaculture species escape into surface waters of the Gila River basin. There have also been proposals to use the CAP aqueduct itself as an aquaculture facility using caged culturing (Mueller 1989). Mueller believed that the aqueduct would be suitable for that use. At present there are no plans for aquaculture in the aqueduct (CAWCD 2001b), but it is likely this concept will be seriously reconsidered at least once during the 100-year project life.

As many authorities on nonnative introductions have noted, where aquaculture facilities are present, escapes into the wild are inevitable (Shelton and Smitherman 1984, Welcomme 1988, Courtenay 1993). The aquaculture facilities in the Gila basin are no exception. This is an important consideration in the analysis of effects of CAP on listed species. The CAP aqueduct will play a major role in transport of nonnative aquatic species introduced into the Gila basin through aquaculture and the aquarium trade.

Bait-Bucket Release

Bait-bucket release is a general purpose category which includes a number of purposeful and accidental releases of aquatic species, all of which are unauthorized and many of which are illegal. The most obvious is release of live bait by anglers, either during fishing or disposing of unused bait (Courtenay 1995). Litvak and Mandrak (1993) found that 41% of anglers will release live bait after fishing. Also included are releases by bait producers and dealers, either through accidental escapes or by dumping of unwanted stock. In addition to the species being produced and used as bait, others are sometimes introduced through accidental inclusion in shipments of bait species (Carlton 1992). In a study in North Dakota and Minnesota, 28.5% of the bait purchases from commercial dealers contained fish species that were not legal bait fish (Ludwig and Leitch 1996). In a common broader use of the term, bait-bucket releases may also include unauthorized stockings of a particular body of water by people who want to establish their favorite food, sport, or decorative fish (Welcomme 1988, McMahon and Bennett 1996). It also may include people dumping unwanted pet aquarium species (Courtenay 1993), moving fish or other species to "rescue" them from what the person feels is an undesirable situation, such as a drying pool or canal, or for unknown reasons. This is apparently what occurred when two native suckers were introduced into the CAP aqueduct in 1988 (Mueller 1989).

The use of live bait is permitted in Arizona for 12 species of fish, plus crayfish, and waterdogs (tiger salamanders), all of which are nonnatives and several of which are known to have serious adverse effects on native species. The portion of the state in which use of live bait is permitted is limited and recent changes have restricted use of live bait from most of the Gila River system (AZ Game and Fish Commission Order 40, effective Jan. 1, 1998). The increasing restriction of live bait use will reduce the input of nonnative species into the CAP system through authorized bait use. However, it will do little to reduce unauthorized bait use or other forms of "bait-bucket" transfer not directly related to bait use. In fact, those other "bait-bucket" transfers are expected to increase as the human population of Arizona increases and as nonnative species become more available to the public through increased aquaculture, increased aquarium trade, and increased distribution through mechanisms such as CAP.

It is through bait-bucket transfer that invading nonnative aquatic species often move over, through, and around what are thought to be insurmountable obstacles, such as dams. The reasons why people may move species from below to above a dam or other obstacle are many, and include those already described in this section as well as reasons unknown to us. For example, nonnative sheepshead minnow have continued to move upstream in the Pecos River in Texas at a rapid pace despite the presence of six irrigation diversion dams and one major dam (Red Bluff Reservoir) (USFWS 1998b). Their movement over apparently insurmountable obstacles is thought to have occurred through bait-bucket transfer. This invasion is having serious adverse effects to the native Pecos pupfish through hybridization (Wilde and Echelle 1992). A local example of this is tilapia in the Gila basin, which have dispersed up the Salt and Verde Rivers over at least one minor (Granite Reef) and two major (Stewart Mountain and Bartlett) dams (T. McMahon, AGFD, pers. comm., August 1998).

The CAP aqueduct and the recharge, recreational, and decorative ponds that will use CAP water or other water made available by CAP use elsewhere, are attractive and convenient places for people to dispose of unwanted pet fish, a common means of introduction (Courtenay 1993). Although the aqueduct is fenced, it is not difficult to drop small items, like fish or crayfish, into the aqueduct, particularly on bridge crossings. The aqueduct skirts the northern edge of Phoenix, and many of the recharge, wetland, and recreational waters created by CAP or CAP in-lieu water are in or near the metropolitan areas of Phoenix and Tucson. Any body of water in the desert exerts a strong draw on humans and any of those CAP water bodies that are open to public access will receive heavy use. The presence of open water in or near a major metropolitan area is an "attractive nuisance" for bait bucket release, providing an easy, accessible place for these releases to occur.

As with aquaculture, and aquarium releases, bait-bucket releases will occur with or without the CAP, but will be increased in frequency, probability, and area of effect by CAP. The CAP and CAP-based recharge and recreation ponds provide bodies of water to receive and transport species entering the system from aquaculture, aquarium, and bait-bucket releases. In addition, for bait-bucket releases, the CAP has a second effect, by providing species and individuals to be the subject of bait-bucket release. As a hypothetical example, species X, previously unknown from the Gila River basin, is transported from the Colorado River through the CAP aqueduct into the Salt River where it moves up the river to the base of Stewart Mountain Dam. People catching bait minnows at the base of the dam put species X into a bucket along with other fish, tadpoles, and invertebrates and drive to Saguaro Lake, where after they finish fishing, they dump the remaining bait into the lake. The proximate cause of that introduction was bait-bucket transfer; however, the ultimate cause was the placement of the species by CAP into an area where it became an easy subject for bait-bucket transfer. The CAP will substantially increase the risk of bait-bucket introduction of nonnative species into new areas by increasing the availability of those species to the public.

Releases for Biological Control

Nonnative species are sometimes introduced for biological control of other species, often of earlier nonnative introductions that have become problems (Drea 1993). With aquatic species, biological control often becomes needed when native or nonnative species become pests due to habitat modification, such as increased need for mosquito control due to impoundment of streams or created wetlands or an increased need for aquatic weed control because of channelization. In Arizona within the past 10 years, the Service has been increasingly asked for support of, or authorization to, introduce nonnative aquatic species for biological control. One of the factors in the increased need for introductions of nonnative aquatic species for biological control is CAP.

In addition to escape into the wild of aquatic species introduced for biological control, there is also the potential for escape into the wild of non-target species which sometimes are included in the imported stock. For example, silver carp have been unintentionally introduced into Arizona as inclusions in shipments of grass carp, although they did not become established (Marsh and Minckley 1983). Besides other fish species, biological control agents may carry nonnative parasites and diseases. Grass carp carry several diseases and parasites known to be potentially transmissible to North American fishes (Nico and Fuller 1997).

The CAP aqueduct itself has been the focus of several proposed or implemented biological control introductions. In the late 1980's, Reclamation placed mosquitofish for mosquito control into areas of the uncompleted aqueduct where standing water was present (USFWS unpub. data). In 1989, grass carp were introduced into the aqueduct for vegetation control (Bawden 1994). Most recently, CAWCD has proposed to introduce black carp into the CAP aqueduct for control of possible future invasions of zebra mussel (J. Garza, CAWCD, pers. comm., October 1997); however, that proposal has since been dropped (CAWCD 2001b).

In addition to direct introduction into the aqueduct of nonnative species for biological control, there are auxiliary aspects of CAP that have, or will, increase the demand for nonnative introductions for that purpose. The most prominent of these is the need for mosquito and other insect control in ponded waters that are part of recharge projects or created wetland projects using CAP or "in lieu" water. This is already a significant issue on Rio Salado Town Lake and has fueled pressure to introduce nonnative fish for biocontrol (AGFD 2000b). Because of the increasing biological control demand from these projects, the Service and Reclamation are now working on a method to substitute use of native species, such as Gila topminnow and desert pupfish, for mosquito control rather than using mosquitofish and other nonnatives. We also anticipate that during the 100-year project life there will be increasing demand for biological control of vegetation in ponds and other impoundments that use or store CAP water or CAP "in lieu" water. Grass carp are already in common use in Arizona (Wright and Sorensen 1995) and tilapia of various species have been introduced for vegetation control, among other purposes, with limited success (Fitzpatrick *et al*. 1981). Other nonnative species that have been proposed or considered for vegetation control in Arizona include silver carp, pacu, and silver dollarfish. Shirman (1984) lists 26 other fish species that are considered to have some potential as biological controls on aquatic vegetation. In the next 100 years at least some of those species can be expected to be introduced in the Gila basin, either legally or illegally, and use CAP waters to disperse into the natural drainages and likely eventually into habitats of the nine listed species considered in this consultation.

ROUTES FOR NONNATIVE AQUATIC SPECIES FROM CAP INTO THE GILA RIVER BASIN

In addition to the general mechanisms by which nonnative aquatic species disperse, nonnative species must find routes to move from the CAP aqueduct into the surface waters of the Gila River basin. However, it is important to consider the question of such routes in the context of the long time frame in which project effects are expected and in the context of the many unknown variables involved (see earlier discussion). Although there are at present several routes by which nonnative species can move from the CAP aqueduct into surface waters, these will change substantially over the 100 years of the project as water uses, irrigation canal routes, recharge project designs, and other factors change to reflect changing human needs, new technology, and increasing human development of the Gila River basin. For example, no recharge projects using CAP water were proposed at the time of the 1994 biological opinion. Now, at least 3 are underway and 10 are planned. Many such changes in CAP and use of its water, some small and some quite large, can be expected over the 100-year project life and the challenge is to put in place a solution that will alleviate the existing CAP nonnative threat as well as many of the future CAP nonnative threats as well. Some future changes, such as if CAP water deliveries were expanded into areas not presently receiving such water, would require additional section 7 analysis and solution, but many, like changes in agricultural practices in the Phoenix area, or increases or changed in the way recharge is conducted, can be resolved now by an “umbrella” approach to nonnative threat removal. This will increase efficiency and avoid costly future delays for additional section 7 analyses and implementation of addition threat removal.

When considering the likelihood of escape from a facility or of colonization of new areas by nonnative species it is important to avoid looking only at the central tendencies of habitat parameters, such as average flow (discharge), modal velocity, median precipitation, usual amount of intermittent pools, normal condition of the canal interconnection, amount of habitat present most of the time, general character of the substrate, ordinary high water mark, commonly available food supply, typical water demand, etc. Species movement is not confined to normal happenings, and often occurs only under unusual circumstances (Mack *et al*. 2000). Some “nonnormal” conditions, like the receding flows that follow the peak of a flood event, are the most likely time for most nonnative aquatic species to make colonizing movements in southwestern stream systems. Cooler water temperatures that result from flooding may also trigger colonizing movements in species that have not invaded under “normal” conditions. Conversely, the warmer temperatures of drought period flows may trigger colonizing movements from other species. “Dispersal is a dynamic event and the conditions that govern it change with time; that is, the effectiveness of all barriers is limited in space and temporary in time” (Stauffer 1984:14).

What some people think of as “normal” conditions may actually occur only a small percentage of the time, thus giving a misleading idea about the likelihood of nonnative species movement. For example, using average flows (discharge) to depict the amount of water a colonizing species would find in a stream channel most of the time is highly misleading. The average is a mathematical artifact, highly influenced by extreme flows, and may never occur in nature except as a transient event. The median flow, which is that number at which half of the flow readings are higher and half are lower, is more likely to be present in the stream, but is still only present part of the time. Similarly, average velocities are highly misleading. A flooding channel may have a calculated average velocity of 15 feet per second (4.5 meters per second) and so seem to be impassible to many fish (Bagley and Marsh 1995). That might be true in a maintained flume, but in a natural channel, there are always areas of much lower and sometimes virtually no velocity. These areas are associated with flow dampening features such as cobble bottoms, logs, submerged and emergent vegetation, and shallow edgewaters and are used frequently by many species to move through areas that would otherwise be impassible (Allen 1995). In addition, “normal” conditions for one factor, such as flow, may not coincide with “normal” conditions for another factor, such as food supply. If one factor is high and another low, colonization may occur, but if the reverse is true, it may prevent successful colonization. “Normal” tolerances of a species may also vary from individual to individual and under varying circumstances. Evolution and colonization both depend to a large extent upon the individuals of a species or populations whose adaptations are slightly different thus allowing them to thrive where the "normal" individual would perish (Darwin 1859, Stauffer 1984).

One of the most striking examples of the fallacy of an analysis of the probability of species movement and colonization based on "normal" conditions is the issue of fish movement in "dry" streambeds. Many people characterize large portions of the drainages of the Gila River basin as "dry." In reality, there is no such thing as a "dry" streambed; by definition all drainages have water in them at least part of the time. A streambed that is dry during part of the time is rapidly colonized by aquatic species as soon as water is present. A good example of this is the yearly recolonization of the Salt River Project canals following the yearly dryup of 30-50 days for canal maintenance (Marsh and Minckley 1982). Approximately two dozen species of fish recolonize the canals once they are rewatered.

In the biological assessment for the Santa Cruz subbasin portion of the CAP (USBR 1996), Reclamation provides data showing that the "normally dry" Santa Cruz River near Continental (south of Tucson) had a period of 150 consecutive days of flow in the winter of 1983-84 as well as several periods of flow exceeding 30 consecutive days during other years. In the "normally dry" reach of the Gila River near the mouth of the Santa Cruz, there is flow in the river about 30% of the time (USGS 1998). Although USGS data are limited on stream reaches that many people consider to be "normally dry;" the San Pedro River at Winkelman has flow 60% of the time; the Santa Cruz River near Laveen, 40%; the Agua Fria River at Avondale, 99%; the Hassayampa River near Morristown, 50%, and Centennial Wash near Avondale, 1%. Some of these figures, such as the Agua Fria at Avondale reflect agricultural and municipal effluent.

Even in a stream with flow only 1% of the time, there are periodic opportunities for aquatic species movement. CAWCD (1995) cites USGS data indicating that the flow at Morristown on the Hassayampa River must reach 800 cubic feet per second (23 cubic meters per second) for the flow to extend to the Gila River. That level of flow occurs only 1% of the time (USGS 1998) or on the average only 4 days per year. From that, CAWCD concludes that nonnative aquatic species could not move upstream in the lower Hassayampa. However, many species could easily cover that length of stream in 4 days under the right set of circumstances. But, that 4 day window is an average and the amount of time the Hassayampa River will actually flow to the Gila River will vary substantially from year to year. According to USGS calculation, 30 consecutive days of 800 cubic feet per second or greater could be expected at Morristown on the average of about every 10 years (USGS 1998), thus providing a substantial opportunity for nonnative species movement. Even the small Salt River tributary of Indian Bend Wash, much of the floodplain of which is parkland in urban Scottsdale, has flow 1% of the time. A moderate flood in Indian Bend Wash in July 1999 is considered to have been the movement corridor used by many of the 11 species of nonnative fish that entered the newly filled Rio Salado (Tempe) Town Lake (AGFD 1999). Periods of flow such as these provide ample opportunity for colonization movement by nonnative species, either as long distance movement by individuals or several short distance movements by individuals of successive generations which find pockets of suitable watered habitat to survive in during the dry periods. A green sunfish was recently found beside a pool in an otherwise dry streambed in Arnett Creek, a small intermittent stream near Superior (J. Stefferud, USFS, pers. comm., April 2001). The pool was at the base of a constructed fish barrier in a "normally dry" section of the creek, a little over a mile (1.6 kilometers) upstream from the confluence with the intermittent Queen Creek, which itself flows only 30% of the time (USGS 1998). Above the barrier Arnett Creek has been treated with piscicide to remove all fish.

There are two primary ways nonnative aquatic organisms can enter the Gila basin via CAP. The first is direct transfer from the CAP aqueduct. The species may have entered the aqueduct in a number of ways. The most likely entry point for nonnative species into the CAP aqueduct is at the source at Lake Havasu and at Lake Pleasant. Lake Havasu is the source of nine nonnative fish currently in the CAP canal and Lake Pleasant is the source of one (Mueller 1989). Species may also be transported into the aqueduct attached to equipment or in water being used for construction or maintenance purposes (Carlton 1992). Species may move into the aqueduct from connecting canals and waters, although in some cases the turnout mechanisms have substantial obstacles to upstream movement. There are many road crossings and other public access points where releases of aquatic organisms into the aqueduct or connecting waters can occur. Persons with access to the CAP aqueduct and other facilities may release fish. G. Mueller received verbal reports that largemouth bass and goldfish were released into the CAP by canal construction workers (Matter 1991). Mueller (1989) also documented trespass angling in the CAP as well as bait-bucket introduction of two native suckers.

Routes of egress for nonnative species from the CAP aqueduct can be categorized into four general areas: 1) "permanent" routes, such as a turnout into a reservoir, irrigation canal or an in-channel or floodplain recharge project, 2) "temporary" routes, which occur only periodically for short periods, such as flushing of siphons or sumps, or inundation of irrigation waters during flooding, 3) "emergency" routes, such as canal overflow during flooding, failure of irrigation canals alongside or on crossings of surface stream channels, and failures or mechanical malfunctions of the aqueduct, irrigation canals, or recharge project features, and 4) "other" such as bait-bucket transfers, overland movement of aquatic species capable of such movement (crayfish, frogs, "walking" catfish), wind-borne seed, etc. Some of these routes may not function except in conjunction with another set of circumstances. For example, purging excess CAP water from an siphon into a completely dry channel would not result in a water route for nonnative dispersal, but purging the same siphon into the same channel might result in a species dispersal if it was accompanied or followed by sufficient rain.

Permanent, temporary, and emergency routes for nonnative aquatic species out of the aqueduct into Gila River basin surface waters will occur through a variety of releases of untreated, unfiltered CAP water into areas where the water may reach natural channels. There are several main areas in which this could occur, including Lake Pleasant, Town Lake, the Salt River/CAP interconnection, and the Florence-Casa Grande Canal connections and Picacho Lake. There are also a number of smaller areas, including any in-channel recharge water bodies, and any irrigation canals and sumps. In addition, there are features of the system, such as cleanout valves from siphons that periodically may place untreated CAP water into drainageways or surface waters. The cleanout valve on the Agua Fria siphon is now being used to turn water out of the aqueduct into the Agua Fria recharge project in the floodplain of that river (D. Hagstrom, USBR, pers. comm., March 2001). In addition, siphons crossing surface drainages are vulnerable to breakage and release of water during flood events, as are canals which cross or parallel drainages. Although CAP water users do not intend for such accidents to happen, a significant proportion of nonnative introductions occur through accidents in facilities where nonnative species are theoretically "contained" (Carleton 1992).

Nonnative aquatic species moving out from the CAP aqueduct may not move directly into surface waters of the Gila basin. They may move first into other canal systems or into irrigation ditches. From there they may move into surface waters. This was the route that would occur at the Pima Lateral Feeder Canal turnout where species from the aqueduct would move first into the Florence-Casa Grande or Pima Lateral canals, then up the Florence-Casa Grande canal into the Gila River. They might also move down the Florence-Casa Grande into Picacho Lake, where they might establish a population that could feed individuals up and downstream through various canals before reaching the Gila or Santa Cruz Rivers.

Other routes out of the aqueduct depend upon human assistance, either intentional or unintentional. Despite substantial measures to prevent public access to the CAP aqueduct, there are still some instances where such access occurs and which offer the potential for people to move species from the aqueduct into other waters. Mueller (1988) reported that a tagged fish that was released in the aqueduct was caught by an angler in the Salt River. Although that fish may have moved by itself, Mueller considered that very unlikely. The greatest likelihood is for species to move out of the aqueduct as unobserved passengers on equipment or other animals. Some species such as zebra mussel, are often transported on equipment (Warren 1997). Giant salvinia is thought to have moved between some nearby areas attached to turtles, frogs, or other animals (USGS 2001). Others, like bullfrogs may simply use the aqueduct as a temporary stop on an otherwise overland journey. Bullfrogs will climb chain link fences, such as surround the aqueduct, and have been recorded to move up to 7 miles (11 kilometers) overland (C.Schwalbe, Univ. of AZ, pers. comm., February 2001).

The second source of nonnative aquatic species from the CAP system is through waters created or associated with the use of CAP water. If raw CAP water is used to create surface water, especially ponded water, in perennial or near-perennial fashion, the nonnative species present in the CAP aqueduct will likely colonize that water. This water body will then act as a source for movement of these species into other areas, through direct movement of water (e.g. Town Lake water moving down the Salt River during floods), bait bucket transfer of species (e.g. removal of mosquitofish from a recharge pond for use in private ponds), or movement of the species themselves, either alone or attached to people, equipment, or animals (e.g. crayfish walking away from a recharge facility). If the water bodies is created using treated CAP water or using water made available through use of CAP water, then it should arrive at the site either free of nonnative aquatic species or with only those already found in the area. However, any water body accessible to the public will become an attractive nuisance in the sense that it will provide the opportunity for unauthorized stocking of all kinds of nonnative aquatic species. It will also provided habitat for escapees from aquaculture facilities, thus increasing the risk of accidental introduction by that route. It may also increase the pressure for authorized stocking of nonnative sport, biological control, or ornamental nonnatives, thus increasing the spread of those species.

"Artificial waters seem to serve as stepping stones for exotic species as they spread geographically" (Blinn and Cole 1991). Despite laws and efforts to prevent the public from stocking nonnative species into ponds and other surface waters, species inevitably appear in any newly created water (W. L. Minckley, ASU, pers. comm., 1988-1998). Accessibility plays a part, and easily accessible ponds such as on the golf course at Sun Lakes often receive rapid unauthorized stockings of decorative, sport, and other species (Marsh and Minckley 1983). However, even sites of low accessibility may receive unauthorized stockings, such as fathead minnow found in a concrete, windmill-fed trough up 3 miles (5 kilometers) of four-wheel drive track on a remote ridge on the Tonto National Forest about 10 miles (16 kilometers) north of Globe, Arizona (Stefferud 1989). Species from these authorized stockings often spread to other areas, either by connecting waters or additional bait-bucket transport.

Once a nonnative species has moved from the CAP aqueduct or out of ponded water in a recharge or created wetland project that uses CAP or CAP in-lieu water, there are then a wide variety of mechanisms and routes by which it may move into habitats of spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, Apache trout, and bald eagle. Species that have the ability to move through the air (e.g. seeds, insects, etc.) or across land (e.g. frogs, crayfish, etc.) clearly can move from water to water until dispersed throughout the basin. For species which can move only in water, the most direct routes are upstream or downstream into the Agua Fria from Lake Pleasant, and upstream in the Gila and San Pedro Rivers. The Salt and Verde Rivers are less likely to experience invasions from CAP introduced nonnatives because of the presence of two large dams on the Verde River and four on the Salt River. Movement upstream in the Gila River would be similarly inhibited by Coolidge Dam. However, once a CAP introduced species makes it to the base of any of these dams, the likelihood of their bait bucket transport into the reservoir is greatly increased. Due to their design, Ashurst-Hayden and Granite Reef Diversion Dams on the Gila and Salt Rivers are not considered to be significant barriers to upstream fish movement.

WHAT LISTED SPECIES HABITATS ARE MOST LIKELY TO BE INVADED BY CAP MEDIATED NONNATIVES?

Spikedace and Loach Minnow

The areas occupied by the listed fishes vary substantially in vulnerability to nonnative aquatic species introduced or spread via CAP. For spikedace and loach minnow, the most vulnerable habitats are in the middle Gila River, Aravaipa Creek, and the San Pedro River. These areas are within direct access of nonnative species moving up the Gila River or up the Florence-Casa Grande Canal, both of which receive water from CAP, either directly or indirectly. The Gila River, being in close proximity to the CAP aqueduct, is also vulnerable to bait bucket or accidental transport of species from the aqueduct. As a result of the 1994 biological opinion, a paired set of fish barriers has just been completed on lower Aravaipa Creek, thus substantially reducing the risk to that habitat. However, the middle Gila River, which is occupied by spikedace and is designated critical habitat for spikedace and loach minnow, is poorly protected. The electrical barrier on the Florence-Casa Grande canal and Ashurst-Hayden Diversion Dam are the only preventative measures between areas of CAP introduction and the listed species habitats. Neither of those measures are entirely effective. The San Pedro River, most of which is designated critical habitat for both species, and which is considered a very important recovery area for those species, is equally vulnerable.

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

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

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

Gila Topminnow and Desert Pupfish

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

Gila topminnow are present in the Hassayampa River basin at Palm Lake on The Nature Conservancy preserve near Wickenburg. Two habitats identified for augmentation stocking are also located in the subbasin at Bain Spring and Campbell Flat Spring. The level of risk from CAP introduced nonnatives at these sites is low.

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

The Verde River basin has a number of Gila topminnow populations and recovery habitats. Most of these are isolated springs and have a very low probability of effect from CAP introduced or spread nonnatives. However, Lime Creek, which enters Horseshoe Reservoir and Horse and Red Creeks, which enter the river above the reservoir, are periodically connected to the Verde River. The potential for CAP introduced nonnatives to reach Horseshoe Reservoir is moderate and any species reaching there would have open access to Lime Creek and the Gila topminnow population. This could result in loss of this population. The likelihood of such effects to Horse and Red Creek are much less, but there is still some potential for loss of these habitats to CAP introduced or spread nonnatives. Fossil Creek and the East Verde River, which both were stocked with Gila topminnow at one time, have been identified for augmentation stocking. Both are normally connected to the Verde River and would be highly vulnerable to any nonnative species from CAP that successfully surmounted both Bartlett and Horseshoe Dams.

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

Gila topminnow sites along the middle Gila River (Mescal Warm Springs) and the San Pedro River (Buehman Canyon, Babocomari River, O'Donnell/Canelo Cienega) are at risk from CAP introduced and spread nonnatives. Only Mescal Warm Springs presently supports a thriving population and it is isolated from the Gila River by a natural barrier. Portions of Buehman Canyon are above a natural barrier and O'Donnell/Canelo Cienega has several small diversion dams between it and invading species from CAP that would substantially lower the likelihood of species reaching those sites. There is one desert pupfish population at the Boyce-Thompson Arboretum, in an impoundment just off Queen Creek. The distance from the Gila River and the impoundment dam make the risk to this population from CAP mediated nonnatives fairly low. The controlled situation at the admission-required Arboretum should help prevent bait bucket transfers, however bait bucket releases have occurred several times, including the fathead minnow that are presently in the pond.

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

Razorback sucker and Colorado Squawfish

Both razorback sucker and Colorado squawfish exist in the Gila basin only as repatriated, and apparently not yet reproducing, populations. The middle and upper Verde River, the upper Salt River and the Gila River above Coolidge Dam are designed critical habitat for razorback sucker. The most important of the repatriated populations are in the upper Salt and Verde Rivers. As discussed for spikedace and loach minnow, the major dams on both of these rivers reduce the likelihood of invaders from CAP to a low to moderate risk. However, the heavy recreation on the reservoirs is a significant factor in that risk and may be the mechanism that allows a species from CAP to achieve the upper Salt or Verde Rivers. Other populations of razorback sucker are located in the Gila River above San Carlos Reservoir, Bonita Creek, the San Francisco/Blue Rivers, and possible recovery habitat exists in the San Pedro River. The status of the populations in these areas is unknown and repatriation efforts to date do not appear to be successful. The relative accessibility of these areas to CAP introduced or spread nonnatives is the same as discussed earlier for spikedace and loach minnow.

Gila Trout and Apache Trout

In the Verde River system, Gila trout is present as a repatriated population in Dude Creek. Dude Creek is a tributary of the East Verde River, which empties into the Verde River upstream of Horseshoe and Bartlett Dams. Dude Creek also has a small natural fish barrier. In the San Francisco River system, upstream of the Gila River's Coolidge Dam, another repatriated population is found in Raspberry Creek, a tributary of the Blue River. Raspberry Creek also has a natural fish barrier. Because of the distance, the presence of multiple barriers, and the remoteness of the habitats, these populations of Gila trout are at a low risk from CAP mediated nonnative aquatic species. The natural and repatriated populations of Gila trout in the upper Gila and San Francisco River basins in New Mexico are in small tributary streams with natural or constructed barriers. Although there is some potential for species introduced by CAP to penetrate these small drainages over time, this likelihood is low for the same reasons as given above.

Apache trout are found in the Gila basin only in small headwater streams in the upper Salt River system. The long distance between these habitats and the CAP, the presence of four major dams on the Salt River, and the natural or constructed barriers on each of the Apache trout streams make these habitats very unlikely to be invaded by nonnative aquatic species introduced or spread via CAP.

Bald Eagle

Bald eagle are most vulnerable to nonnative aquatic species introduced or spread via CAP at Lake Pleasant, along the middle Gila River below San Carlos Reservoir, and along the lower Salt and Verde Rivers. There is presently one nesting territory at Lake Pleasant, two along the middle Gila, two along the Salt River below Stewart Mountain Dam, and five on the Verde below Bartlett Dam. Thus, 24% of the territories of the desert nesting population of bald eagle are in areas of direct impact from CAP introduced or mediated nonnative species. The additional 2 populations in the upper Gila area, 14 on the Salt River system, and 9 on the upper Verde are at varying risk from CAP mediated nonnatives. As discussed above for the listed fish, the major dams on these systems provide some protection, as do the electrical barriers on the SRP and GRIC canals, but do not completely remove the risks.

EFFECTS OF NONNATIVE AQUATIC SPECIES TO THE SPECIES UNDER CONSULTATION

Spikedace, Loach Minnow, Gila Topminnow, Razorback Sucker, Desert Pupfish, and Colorado squawfish

Introduced nonnative aquatic organisms can affect native species and their habitats, in numerous ways. Nonnative fish, amphibians, invertebrates, and other aquatic fauna may affect native fish through predation (Meffe *et al*. 1983, Meffe 1985, Clarkson and DeVos 1986, Marsh and Brooks 1989, Propst *et al*. 1992, Rosen *et al*. 1995, Rinne 1999), aggression and harassment (Meffe 1984, Dean 1987, Lima 1998), resource competition (Schoenherr 1981, Arthington and Lloyd 1989, Johnson and Hubbs 1989, Lydeard and Belk 1993, Baltz and Moyle 1993, Douglas *et al*. 1994), habitat alteration (Allen 1980, Aquatic Nuisance Species Task Force 1994, Fernandez and Rose 1996), aquatic community disruption (Hurlbert *et al*. 1972, Ross 1991), introduction of diseases and parasites (Sinderman 1993, Clarkson *et al*. 1997, Robinson *et al*. 1998), and hybridization (Dowling and Childs 1992, Echelle and Echelle 1997). Nonnative aquatic plants, particularly if more aggressive and prolific than native plants, can reduce available habitat with abundant growth (e.g. water cress), alter water quality (e.g. giant salvinia), and could potentially cause waters to dry (e.g. salt cedar) (McKnight 1993). It is well documented in the literature that nonnative fish species can affect individuals, populations, species, and whole native fish communities (Propst and Stefferud 1994, Rinne and Janisch 1995, McMahon and Bennett 1996, Richter *et al*.1997). Entire faunas are undergoing homogenization as a result of continuing introductions of a relatively small suite of nonnative species and unique community assemblages are being lost and replaced by assemblages that are similar to other areas (Soule 1990, Radomski and Goeman 1995).

There is abundant evidence of the adverse effects of nonnative fish on spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, and Colorado squawfish. The listing of all of these species was based, in part, on adverse effects of nonnative species (Stefferud 1984, USFS 1985b, 1986a, 1986b, 1986c, 1991). Native fishes of the Colorado River basin, including the Gila River basin, evolved in a fish community that was largely free of predatory and competitive interactions (Carlson and Muth 1989, Minckley and Douglas 1991). Many of the species, such as Gila topminnow and desert pupfish inhabited areas of the streams in which they were the only fish species present (Minckley 1999). Because of this evolutionary history, the native fishes of the Gila River basin are highly susceptible to adverse effects from nonnative fishes, most of whom evolved in highly complex fish communities where predation and competition were substantial formative forces.

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

It is not possible to predict accurately what species CAP might introduce or spread that would invade habitats of spikedace and loach minnow and cause adverse effects. Many of the species discussed in the earlier section regarding what species are likely to invade through CAP, might be detrimental if they were to penetrate spikedace and loach minnow habitat. Mechanisms of effect are varied and broad. Some existing species, such as green sunfish, are clearly predatory and many potential invaders, such as most catfish, would also simply eat spikedace and loach minnow. Ruffe, which is thought to have caused declines in emerald shiner populations through predation (Fuller *et al*. 2000), could be expected to prey on spikedace. Competition may be an important factor with many species that might invade. Round goby, a benthic dwelling species, is thought to compete with sculpins and darters (Goodchild 2000) and could also be expected to compete with loach minnow. Many of the Mississippi drainage shiners might compete with spikedace, similarly to the already present red shiner (Douglas *et al*. 1994). Various cichlids, such as tilapias, may substantially alter habitats. Inland silversides, a Mississippi basin native, has been introduced into Arizona's flanking states of New Mexico and California. In California it has resulted in displacement of the hitch, Sacramento blackfish, and contributed to extinction of the Clear Lake splittail (Moyle 1976, Fuller *et al*. 1999). The silversides subsequently moved hundreds of miles through the Sacramento-San Joaquin Delta, California Aqueduct and interconnected canals and into several reservoirs in southern California (Swift 1993). A small fish, the inland silversides prefers alkaline waters and is usually found at the surface of clear, quiet water over sand or gravel (Page and Burr 1991). It feeds on aquatic insects and zooplankton (Sublette *et al*. 1990). These characteristics, plus its propensity for upstream movement and ability to rapidly establish large populations indicate that inland silversides could be expected to be a major threat to spikedace and Gila topminnow if it invaded the Gila basin.

Gila topminnow and desert pupfish have both been extirpated from substantial portions of their historic ranges by nonnative fishes. Mosquitofish have been implicated in many losses of Gila topminnow (Schoenherr 1974, Meffe 1984 and 1985, Marsh and Minckley 1990, Minckley 1999) and have affected desert pupfish, although to a lesser degree (Schoenherr 1988). Tilapia and mollies have been implicated in substantial population declines in desert pupfish (Matsui 1981, Schoenherr 1988). Largemouth bass have had adverse effects to Gila topminnow (Stefferud and Stefferud 1994) and caused the extinction of another endemic Gila basin pupfish, the Monkey Springs pupfish (Minckley 1973).

There are many nonnative fish that might enter the Gila River basin through introduction and spread via CAP that could have devastating impacts to Gila topminnow and desert pupfish, at least in those habitats with connectivity to the rivers and streams of the basin. The pike killifish has been known to extirpate mosquitofish from habitats into which it is introduced (Courtenay and Meffe 1989, Fuller *et al*. 2000) and would most certainly do the same to Gila topminnow. Oriental weatherfish may alter habitats and ecosystems and could thrive in soft substrate areas favored by Gila topminnow and desert pupfish (Dill and Cordone 1997, Fuller *et al*. 2000). Nonnative pupfishes might hybridize with desert pupfish, such as has happened to Pecos pupfish after invasion by sheepshead minnow (Echelle and Connor 1989).

In addition to the substantial adverse effects nonnative fish have had on remnant natural populations of razorback sucker and Colorado squawfish (Pacey and Marsh 1998, Tyus and Saunders 2000), the repatriation of razorback sucker and Colorado squawfish into the Gila River basin has met with limited success, to a large degree due to nonnative fish (Marsh and Brooks

1989, AGFD 1998b). As discussed in more detail under effects to bald eagle, stocking efforts on the upper Salt River have been largely unsuccessful due to heavy predation and dominance of flathead and channel catfish. Because both razorback sucker and Colorado squawfish are large fish, many of the smaller nonnative fish are not of substantial concern, although predation on larvae by red shiner has been documented for Colorado squawfish and similar predation by other small nonnatives could be expected (Ruppert *et al*. 1993, Dunsmoor 1995). Nonnative introductions via CAP that might significantly affect razorback sucker and Colorado squawfish would most likely be large predatory species or species which alter habitats or carry pathogens. If the incipient spread of white and striped bass via CAP reaches into Horseshoe Reservoir, the razorback sucker that use that reservoir could be impacted by predation. Predation on larval and juvenile razorback sucker is a major factor in the decline of reservoir populations on the Colorado River (Minckley *et al.* 1991) and striped bass are a major part of that predation. Strange species, such as swamp eel, which has now invaded Florida, Georgia, and Hawaii, could move through irrigation systems connected to CAP and eventually find its way into backwater habitats used by razorback sucker. Swamp eel is highly predacious and can also move overland and survive drought by burying in wet mud. Several tilapia species have substantial potential for habitat alterations that could adversely affect razorback sucker and Colorado squawfish, particularly in larval and juvenile habitats (Shireman 1984, Dill and Cordone 1997).

There is less available evidence of adverse effects to the eight listed fish from non-fish nonnative species. However, the non-fish element of nonnative aquatic species arriving or spreading through CAP may be significant because we know less about the potential effects and are less prepared to deal with them, and because their more varied means of movement make them more difficult to control. “Non-fish” is a very large and diverse group of aquatic species. Effects of some invading nonnative non-fish may be more difficult to discern because they may be more indirect than those of nonnative fish, involving disruption of food chains and subtle habitat changes.

The two species of crayfish that already exist in the Gila River basin have had negative impacts on aquatic habitats and on amphibians (Pister 1979, Deacon and Williams 1991, Fernandez and Rosen 1996, Gamradt and Kats 1996). Many biologists feel that crayfish may have adverse impacts on spikedace and loach minnow, although no mechanism has been demonstrated. However it is known that large crayfish will capture and eat darters, which are ecologically similar to loach minnow, and there may be food and habitat competition between darters and crayfish (Keller and Moore 2000). Conversely, crayfish make up a large portion of the diet of smallmouth bass and flathead catfish in the Verde River, perhaps benefitting native fishes (Parmley and Brouder 1998). It is likely that both a predatory and competitive relationship exist between Gila topminnow and crayfish. In Cave Creek, Gila topminnow and native longfin dace populations crashed coincidentally with a dramatic upsurge in abundance of northern crayfish (Stefferud 1993, Young and Bettaso 1994). Enhanced movement throughout the Gila River basin due to the CAP interconnection of subbasins may enhance existing crayfish populations, and may enable spread of other species. Nonnative crayfish invasions have caused substantial concerns in other areas (Lodge *et al*. 2000) and several species, such as the rusty crayfish, may be expected to invade the Gila River basin in the future.

Because of their small size and broad array of habitat utilization, molluscs are a likely group for introduction and spread via CAP. The Asian clam is abundant throughout the CAP aqueduct (Mueller 1989) and has likely already been spread into the Santa Cruz subbasin, where it did not exist prior to CAP water deliveries (see earlier discussion under potential species for spread within the Gila River basin). Effects on native fish are not documented; however, Asian clam can build very dense populations and may significantly affect nutrient availability and cycling (Lauritsen 1986, Sickel 1986, Devick 1991, Strayer 1999). Although we have not been able to determine the reasons for the recent decline of spikedace in the upper Verde River, the thriving population of Asian clam in that system may alter the habitat for spikedace and interact with other factors contributing to that decline. The Verde River is the only existing location where Asian clam coexist with spikedace or loach minnow. Asian clam is a benthic species and in areas where populations are heavy, living clams and dead shells could interfere with habitat use by loach minnow.

Zebra mussel, and its close relative the quagga mussel, are expected to make their way to Arizona. There have already been zebra mussel found on two boats at Lake Pleasant (Arid Lands Aquaculture 2000). If zebra mussel is introduced into Lake Pleasant, it will undoubtedly colonize the CAP aqueduct. It is because of this likelihood that CAWCD proposed in 1997 to introduce black carp. Until the species invades, we cannot determine what effects zebra mussel will have to the listed fish, but like Asian clam, zebra mussel causes significant changes in nutrient cycling (Mackie 2000).

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

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

Impacts of nonnative aquatic reptiles on native fishes in Arizona have not been explored. However, spiny softshell turtles and sliders are commonly found in the Gila basin and both are carnivores which consume fish on a regular basis (SWCA 1996, Degenhardt *et al*. 1999, AGFD 2001a). Use of the aqueduct and CAP created waters for spread of these two and other carnivorous nonnative turtles is likely. There are concerns regarding Rio Salado Town Lake and its potential to increase the likelihood of escape and dispersal of the several varieties of nonnative turtles at the Phoenix Zoo (J. Howland, USFWS, pers. comm., 1999).

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

Effects of nonnative plants on native fishes are more difficult to document than for animals because the effects are more indirect. It is likely that water cress, which has been spread throughout the entire Gila basin, has significantly modified backwater habitats occupied by Gila topminnow, desert pupfish, and larvae and juveniles of other species. However, no data exist to demonstrate this and effects are obscured by the many other substantial changes to the habitat. Giant salvinia, recently discovered in the Colorado River, has the potential for serious adverse effects to all native aquatic species. Gila topminnow and desert pupfish could easily be extirpated by this plant. Giant salvinia mats shade out native vegetation, and can deplete dissolved oxygen in the water (Thomas and Room 1986). Its ability to completely and rapidly cover pooled or low-velocity water indicate it would be highly detrimental to Gila topminnow, which feed at the water surface in low-velocity areas. A plant similar to giant salvinia, the European frog-bit, has been introduced into the northeastern United States and is gradually spreading westward through the Great Lakes (USGS 2001). Like giant salvinia, European frog-bit forms dense floating mats on the surface of quiet waters (Upwellings 2000). Other invasive nonnative aquatic plants that have the potential to cover most or all of the water surface, such as water hyacinth and water lettuce (Schmitz *et al*. 1993), would also likely adversely affect Gila topminnow and desert pupfish through interference with feeding patterns and reduction of dissolved oxygen.

Overall, there is an enormous potential for nonnative aquatic species introduced or spread through CAP to adversely affect spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, and Colorado squawfish. Invasion of occupied habitats is likely, and over the 100 year CAP project life, may result in extirpation of one or more populations of spikedace, loach minnow, and Gila topminnow. Razorback sucker and Colorado squawfish recovery efforts in the Salt and Verde Rivers may be damaged or precluded due to nonnative aquatic species introduced or spread via CAP. Recovery of Gila topminnow and desert pupfish is likely to be significantly curtailed as potential recovery habitats are invaded by CAP introduced or spread nonnative species thus precluding their use for repatriated populations of the two native species. Critical habitats of spikedace and loach minnow that are not presently occupied may be excluded from repatriation in the same manner. This is particularly true for those in the most likely path of nonnative invasions from CAP, such as the San Pedro River.

Gila and Apache Trout

Past and present threats to Gila and Apache trout from nonnative aquatic species have come primarily from introduced trouts, mostly rainbow and brown trout (Dowling and Childs 1992, Propst *et al*. 1992, USFWS 1993). Although rainbow trout have been recorded from canals connected to the CAP aqueduct, the potential for the CAP to play a role in the dispersion of trout is low. Low elevation waters, such as the aqueduct, connected canals and ponds, do not support trout through the summer due to high water temperatures (AGFD 2000b). Other streams and lakes within the range of Gila and Apache trouts continue to be stocked with nonnative trouts for sport purposes (AGFD 2001b) and the risk of reinvasion of Gila and Apache trout streams, where nonnative trouts have been removed, comes from these. The colder waters found in Gila and Apache trout habitats are generally not hospitable to the more warm-water adapted nonnative fish that are the most likely to enter the system via CAP. In addition, the habitats of Gila and Apache trout are a long distance away from the CAP aqueduct and are buffered by mainstem dams and natural fish barriers.

However, this does not mean that there is no potential for adverse effects to these two species from CAP introduced and spread nonnative species. The primary concern to Gila and Apache trout from CAP mediated nonnatives is from species that are only semi-obligate aquatics tolerant of a wide variety of water temperatures, such as frogs, turtles, crustaceans, and insects. For example, northern crayfish have colonized waters in the Gila basin ranging from trout waters at over 8,000 feet (2,440 meters) elevation to low desert waters at less than 1,000 feet (300 feet) (Inman *et al*. 1998). Other crayfish are available in the aquarium trade in Arizona and may also be used for bait (although illegally), including the Everglades crayfish and what is probably the Australian redclaw crayfish (Inman *et al*. 1998). Rusty crayfish, a problem species in many places in the northern United States, has already been introduced into New Mexico (USGS

2001). Crayfish can live out of water for extended periods, even months for some species, as long as their bodies are damp and their gills are wet (Huner 1997) thus making them able to move into areas that many other CAP mediated species cannot access. While crayfish have not yet been demonstrated to be a problem for native trout, other crayfish species, or other species with similar abilities to move overland, may be introduced via CAP and eventually enter Gila and Apache trout waters with adverse effects.

Parasites and diseases introduced via the CAP system are a potential concern to Gila and Apache trout. Introduction of pathogens into Gila basin through the CAP will greatly increase the likelihood of their eventual penetration into even the remote areas where Gila and Apache trout are found.

Bald Eagle

The 1994 biological opinion concluded that although there was some potential for nonnative aquatic species to adversely affect bald eagle, those effects were not expected to be highly significant. Nonnative fish that might replace natives, as a result of CAP introductions and spread, were expected to be as available for eagle prey as the existing natives. This was based, in part, on the findings of Hunt *et al*. (1992) who found that bald eagle prey in Arizona included a large number of nonnative fish species. However, prey analyses are skewed by the fact that, in general, most nonnative fish prey have large bony structures which remain in the nest area, while most native fish prey are almost totally consumed and little remains in the nest area for identification (Hunt *et al*. 1992). Data indicate that native suckers are a more important part of bald eagle diet than prey remains would indicate; 42% of the prey remains in bald eagle nests in the southwest were from catfish or carp with native suckers comprising only 18%, but 35 to 40% of actual prey deliveries to the nest are of catfish or carp, while deliveries of native suckers are 25 to 35%.

Since 1994, a major change has been documented in the status of the bald eagles nesting along the upper Salt River, above Roosevelt Reservoir. Reproductive productivity in these nests has declined from 0.67 in the 1980's to 0.26 in the 1990's (AGFD 2000a). It is believed that this significant decline in productivity is related to the dramatic change in the fish community of the upper Salt River (AGFD 2000a). In 1985, Minckley reported that native fishes were locally abundant to common in the upper Salt River and that flathead and channel catfish were found only in the lower portion of that reach. In the 1986 to 1991 period, fish surveys along the upper Salt River found that native fish were less than 7% of the total fish caught (Hendrickson 1993). Flathead and channel catfish were identified as major predators on native fishes in the upper Salt River, a conclusion which supported earlier findings in the upper Gila River (Marsh and Brooks 1989). This proportion continued in 1992, but was reversed in 1993, when following a major flood native fishes rose to over 90% of the fish caught during that year's sampling (Creef and Clarkson 1993). However, by the 1997-1998 sampling period, native fish had plummeted to only 0.4% (1 sucker) of the fish sampled and Arizona Game and Fish Department (1998b) concluded that "native species are now largely extirpated from this river." Flathead catfish were 60-70% of the fish community, with channel catfish and carp making up most of the rest.

Little has changed on the upper Salt River during that period other than the changes to the native fish community. The eagles in that area nest primarily on cliffs, so that changes in riparian tree abundance and structure should not significantly affect productivity. The area is rugged and has only moderate recreational use. Land uses have not changed significantly and consist primarily of livestock grazing. The dynamiting of Quartzite Falls in 1994 may have allowed catfish and other nonnative fishes to expand their range upstream. Although the events of the upper Salt River are only correlative, it appears that the loss of native suckers from the food base of the eagles has had substantial adverse effects on bald eagle reproduction.

In 1983, McClelland *et al*. reported potential adverse effects from nonnative opossum shrimp to bald eagles at Flathead Lake in Glacier National Park, Montana. This lake and its outlet support a large population of nonnative kokanee that provide a large portion of the food base for wintering bald eagle. The opossum shrimp, which had been purposefully introduced in 1968 to a shallow upstream lake, was not expected to move through the adjoining river because it is not a riverine species (Covich 1999). However, it successfully negotiated the river and invaded Flathead Lake where it had become prominent by 1981. Once there, opossum shrimp caused declines in other zooplankton, with a consequent collapse of the kokanee populations (Covich 1999). As McClelland *et al*. (1983) predicted, this collapse led to declines in the bald eagle population (Covich 1999, Li *et al*. 2000). Other species of fish, such as lake whitefish and juvenile lake trout, benefitted from the opossum shrimp introduction (Li *et al* 2000), but those fish live deep in the water column and do not enter the downstream McDonald Creek, thus making them unavailable to bald eagle predation. Wintering bald eagles dropped from greater than 600 to less than 50 (K.Steenhof, USGS, pers. comm. March 2001).

These examples of serious declines in both nesting and wintering bald eagles due to introduction and spread of nonnative species indicate that over the 100 year project life of CAP it is likely that one or more nonnative species will be brought in or spread by CAP with adverse consequences to bald eagle in the Gila River basin. It is difficult to say what species might affect bald eagle. As the two reported incidents indicate, nonnative fish could directly affect bald eagle or nonnative invertebrates could alter the aquatic food web to the point that bald eagle fish prey are depleted. Effects from CAP mediated nonnatives could occur along both the rivers and in the reservoirs. Striped bass, which invaded Lake Pleasant via CAP, have not yet become a major part of the fish community (AGFD unpub. data) as they have in Colorado River reservoirs (Giusti and Milliron 1988). Striped bass tend to dwell in deeper water, particularly during warmer periods (Matthews *et al*. 1989, Matter 1991), thus potentially making them unavailable to bald eagle predation. If at some point, striped bass become a major component of Lake Pleasant, adverse effects to the bald eagle could be expected. Another species expected to be introduced via CAP that might affect bald eagle could be giant salvinia. This plant can cover large areas of open water, such as at

Lake Pleasant, to a depth of several feet (USGS 2001). If substantial areas of Lake Pleasant become covered with giant salvinia, bald eagle ability to capture fish may be severely limited.

AMELIORATING EFFECTS OF CONSERVATION MEASURES

As part of the proposed action, Reclamation has included several conservation measures that will partially ameliorate the threat of invasion and spread of nonnative fish (and some members of other groups) and the adverse effects to spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, and bald eagle. These measures are described in the Project Description section of the biological opinion. An important component of the conservation measures, and their precursor 1994 reasonable and prudent alternative, is that there is no single solution to the threat of introduction and spread of nonnatives via CAP. The proposed conservation measures contain a multi-part approach, whose parts are expected to work synergistically. It is only as a whole that the conservation measures will be effective.

The just-completed construction of a paired set of barriers to upstream migration of fish in Aravaipa Creek will provide for substantial protection of the spikedace and loach minnow populations there. A proposed barrier on the San Pedro River will substantially reduce the direct threat of introduction and spread of nonnative aquatic species into the upper parts of that subbasin, thus providing protection to the critical habitat of spikedace and loach minnow and possible repatriation habitats of Gila topminnow, desert pupfish, and razorback sucker.

Continued operation of the electrical fish barrier on the Florence-Casa Grande Canal will provide partial protection for areas of the San Pedro River below the barrier, as well as the middle Gila River below Coolidge Dam. If the modifications proposed to the electrical barriers are effective, that protection will increase. However, those habitats are still vulnerable to nonnative aquatic species that are introduced or spread into the Gila River below Ashurst-Hayden Dam, which for structural reasons is not a barrier to upstream fish movement. Continued operation of the electrical fish barriers on the Salt River Project South and Arizona Canals will, if modifications are effective, provide partial protection against nonnative aquatic species from CAP moving upstream into the Salt and Verde Rivers.

However, as has been repeatedly discussed during the earlier consultation on the Gila basin and during informal consultation on the Santa Cruz subbasin, no barrier is 100% effective at stopping upstream movement of fish. The uncertainty of fish movement during flood peaks when the barriers are overtopped and the always-present threat of people moving fish over the barriers make it necessary for the barriers to be only one element in a more comprehensive approach. In addition, the barriers provide protection only against nonnative fish. To that end, Reclamation has proposed a monitoring program to detect nonnative fish in the most likely areas for nonnative invasion from CAP, as well as an information and education program to inform the public of the dangers of nonnative aquatic species and the undesirability of moving or dumping species into the wild.

A portion of the threat from CAP will be from non-fish aquatic species (i.e. invertebrates, amphibians, reptiles, plants, pathogens). While the fish barriers together with the monitoring and management are expected to be near 100% effective in preventing upstream movement of fish, they will not effectively stop many invertebrates, amphibians, and plants. Amphibians, reptiles, and some invertebrates, such as crabs and crayfish can move overland. Insects with adults that fly can surmount any barrier. Invertebrates like the zebra mussel can move attached to equipment. Plants may move via wind-carried seed or may move attached to nets used by monitoring crews. Invasion and spread of these species is much harder to control than that of fish, and the paucity of information on non-fish invaders (their identification, life histories, habitat requirements, and effects on the aquatic ecosystem) make monitoring and management difficult. However, it is nonnative fish that have been documented to be the greatest present threat to native fish and to the bald eagle, therefore, it is assumed that removal of that portion of the nonnative aquatic species threat through barriers, monitoring, and management, along with the limited protection provided against more vagile species through the monitoring and management, can be accomplished at a level sufficient to remove a large portion of the threat.

Management against nonnative species is provided for under the conservation measures by provision of funding to the Service. Use of those funds to control or remove existing nonnative species, provide emergency control of invading species, and to develop innovative methods of nonnative aquatic species control will provide extensive benefit to spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, Apache trout and bald eagle. This management will work with the barriers and monitoring to increase the likelihood that nonnatives species will first be prevented from moving upstream, or if they surmount the barriers then to ensure that they will be detected and controlled.

To address the remaining threat, the conservation measures include actions for recovery “in-lieu” of threat removal. This approach was also used in the 1994 reasonable and prudent alternatives to deal with threats from CAP for which there is no known feasible method to remove or ameliorate. Recovery in-lieu of threat removal will provide for actions to improve the status of the listed species so that remaining threats are of less consequence to the survival and recovery of those species.

Recovery actions for the nine listed species are provided for in two ways. Construction of six additional fish barriers on occupied or recovery habitats of loach minnow, spikedace, razorback sucker, and Gila topminnow will provide protection from new invading species, and will allow removal of existing nonnatives and enhancement or repatriation of the listed fish. These barriers will significantly increase the ability to implement the recovery plans for these species. The barriers will also provide protection of food resources for the bald eagle on some streams. The second part of the recovery actions is through the recovery fund portion of the conservation measures. This fund is for recovery actions only for the listed fish; the bald eagle is not included. It will be used to undertake important recovery actions, including the repatriation of spikedace, loach minnow, razorback sucker, and Gila topminnow into the habitats protected by the proposed fish barriers. Desert pupfish, Gila trout, and Apache trout may benefit from some of these recovery actions, although use of the funds for these species is expected to be minor.

As stated in the biological opinion, there are likely to be temporary adverse impacts to several of the listed species during construction of the fish barriers. In addition, the barriers themselves carry an inherent adverse impact from habitat and population fragmentation (Sloat 1999). Despite these drawbacks, the use of barriers is vital to the continued survival and recovery of the Gila River basin native fish. No other effective means are available to control the onslaught of nonnatives and without such control all of the basin’s native fish likely will be extirpated. To minimize the adverse impacts of construction, reasonable and prudent measures and terms and conditions were set forth in the incidental take statement of the biological opinion. To minimize or compensate for the long-term impacts of fragmentation, nonnative control and removal and repatriation of native species upstream of the barriers is critical. These actions are outside of the authority of Reclamation and will be conducted by the Service, in cooperation with AGFD. An important part of this consultation is the Service’s commitment to the expeditious implementation of these actions.

Delays in implementation of the 1994 reasonable and prudent alternative were of substantial concern to the court in consideration of the need for reconsultation. The largest delays occurred in the construction of the barriers, with the Aravaipa barriers being completed 3 ½ years late. Delays in all other aspects of the reasonable and prudent alternative also occurred. Despite these delays, and in the face of substantial obstacles not with the control of Reclamation or the Service, implementation of the reasonable and prudent alternative is successfully being pursued and the objectives of the reasonable and prudent alternative are being met. Although nonnative species could be introduced or spread via CAP at any time, the probability of introduction of new species increases over time and the 1994 finding of jeopardy to listed species survival and adverse modification of critical habitat was based on long-term threats. Therefore, the delays in implementation that occurred, although they increase the risk of adverse effects, did not significantly change the capability of the reasonable and prudent alternative, now the conservation measure, to remove the threat of jeopardy and adverse modification of critical habitat.

Although there is little that can be done to redress any actually harm that may have occurred during the delays, the conservation measures proposed will compensate for that harm by implementing additional recovery in-lieu of threat removal. The additional barriers to be constructed will assist in major recovery efforts that might not happen otherwise.

Additional delays will undoubtedly occur in implementation of the conservation measures. Because they deal with direct protection from CAP nonnative introduction and spread, the delay of the San Pedro River barrier and the modification of the electrical barriers, as built into the conservation measures, are of particular concern to the Service. Reclamation has committed to completion of one San Pedro barrier no later than March 2006 and the Service believes that time frame can be allowed without jeopardizing the nine listed species or adversely modifying their critical habitats. The second San Pedro barrier called for in the 1994 reasonable and prudent alternative has been dropped in favor of a barrier on a tributary of the San Pedro that can be used to establish a replicate population of spikedace and loach minnow from Aravaipa Creek. Despite the reduction from two to one barriers, the time established for completion of a barrier on the San Pedro River is double that of the 1994 reasonable and prudent alternative. Although the Service is aware of the substantial difficulties encountered in obtaining an easement or purchase of land for the barrier, we believe it is very important to complete the San Pedro River barrier as soon as possible. Any delay of this barrier beyond that encompassed in the conservation measures is likely to alter the conclusion that the conservation measures will effectively remove the potential of jeopardy and adverse modification of critical habitat for spikedace, loach minnow, Gila topminnow, razorback sucker, and desert pupfish.

The modification of the electrical barriers is scheduled, under the conservation measures, to take up to 1 ½ years. This is because of the need to dry up the canals temporarily while the modifications are made. The Salt River Project does not plan to continue their annual canal dryup due to increased effectiveness of vegetation control by nonnative grass carp. The presence of perennial flow in these canals will increase the probability of their harboring and spreading nonnative aquatic species. In light of this, the need for the modifications to increase the effectiveness of the electrical barriers becomes even greater. Any delay of these modifications beyond that encompassed in the conservation measures is likely to alter the conclusion that the conservation measures will effectively remove the potential for jeopardy of all nine listed species and the critical habitat of the spikedace, loach minnow, and razorback sucker. The Service encourages Reclamation to accomplish all of the electrical barrier modifications as soon as possible.

IRREVERSIBILITY AND COST

Once nonnative species become established, they are extremely hard, and sometimes impossible to remove (Aquatic Nuisance Species Task Force 1994) and essentially become part of the local fauna (Minckley and Deacon 1968, Minckley 1973, Coblentz 1990, Courtenay 1993). This means that new species introduced, or new populations of existing nonnative that are established, will likely become permanent biological pollutants and will have cumulative effects on the ecosystem and its functioning. Removal of nonnative fish is expensive for large systems (e.g. Virgin River), and often requires multiple treatments, even for small sites (e.g. Bylas Springs) (Marsh and Minckley 1990, Rinne and Turner 1991, Propst *et al*. 1992). It is also unpopular with the public, some of whom fear the effects of control agents or object to killing of any individual animals (Finlayson *et al*. 2000).

Costs for control of nonnative species can be very high. Annual control costs for sea lamprey in the Great Lakes are $10 million (U.S. Congress General Accounting Office 1992, as cited in

Courtenay 1995). Costs from efforts to control ruffe are expected to exceed $90 million annually (Great Lakes Fishery Commission 1992, as cited in Courtenay 1995).

Not only is it expensive and time-consuming to remove or control nonnative species, but removal often entails use of toxic substances, which affect many species besides the target nonnative (DeMarais *et al*. 1993, Inchausty and Heckmann 1997). Therefore, it is vital that preventative measures be taken to exclude nonnative species from invading or to remove them before they spread or become established.

SUMMARY OF EFFECTS

"No aquatic ecosystem can accept a nonnative species without adjustments" (Courtenay 1993:56). While those adjustments are not necessarily always negative, the knowledge we have of the effects of nonnative aquatic species already present in habitats of the nine listed species and of effects of other nonnative aquatic species to other native species, indicates that introduction and spread of nonnatives is usually highly detrimental to aquatic ecosystems in general and to Gila basin native fishes in particular. Long-term interactions of introduced species and native fish populations are not simple to model or predict (Moyle and Light 1996), but the record clearly indicates that introduction of nonnative aquatic species into southwestern aquatic ecosystems coincides with reduction or elimination of native fishes from those habitats.

The Effects of the Action section of the biological opinion provides a concise summary of the information on effects in this background document. Please refer to that opinion.

REINITIATION

The formal reinitiation notice in the biological opinion gives four criteria that would require reinitiation of this consultation. Given confusion that surfaced during the earlier consultations on this, and on the Santa Cruz subbasin, over the level of commitment required of the Service to conclusions made in opinions issued years or decades ago, it is important to recognize that there are a number of circumstances under which the biological opinion would no longer be valid and reinitiation would be required. Although the Service strives to issue biological opinions that are complete and provide, to the extent possible, for future contingencies, regulations require that the action agency reconsult with the Service if there are excessive takings, new information, project changes, or new species listings. This is particularly important with ongoing actions, such as delivery of water and operation of CAP, where over long project life spans there will be changes in the project, the status of the species may change, the knowledge of species needs expand, and experience in what conservation measures will succeed becomes available.

The first of the reinitiation criteria is if the amount or extent of incidental take is exceeded. In the biological opinion, the amount of take attributable to nonnative species effects on spikedace, loach minnow, Gila topminnow, razorback sucker, desert pupfish, Colorado squawfish, Gila trout, Apache trout, and bald eagle could not be quantified and therefore will be considered to have been exceeded if the conservation measures are not fully carried out as proposed. Therefore, if the conservation measures cannot be fully carried out, for whatever reason, reinitiation of consultation would be required.

The second criterion is if new information becomes available that indicates that the effects analysis in the biological opinion is no longer correct. That is, if new, or newly available, information arises, the effects analysis must be reconsidered and if the new information would change that analysis, then the consultation must be reinitiated to consider that information. For example, if at the end of the 21 years remaining in the period provided for in the recovery and nonnative management funds, it is found that the nonnative threat to the listed species is as great or greater than today, and CAP continues to play a strong role in that threat, then that would constitute new information that would require reinitiation of consultation.

The third criterion is if the proposed action (including the conservation measures) is changed. However, only changes that would alter the effects analysis require reinitiation. If the change in the project would not alter the analysis, its conclusions, or the measures required or recommended in the opinion, then reinitiation is not required. For example, if delivery of CAP water was extended to another portion of the basin, that change would significantly alter the analysis, conclusions, and measures to remove jeopardy and would therefore require reinitiation of consultation.

The fourth criterion is if new species or critical habitat are listed that may be affected by the proposed action. In this case, consultation on the proposed action is required for those species. This can be conducted as a new consultation that will tier to, or augment, the existing opinion or can be a complete reopening of the consultation. For example, the Service has proposed to list the Chiricahua leopard frog as threatened and is considering issuing a proposal to list the Gila chub. If either of those listings should occur, then an addition consultation or reinitiation of this consultation would be required. If, prior to listing, a formal conference is conducted on the Chiricahua leopard frog, then that conference opinion will be converted into a biological opinion following listing and no additional reinitiation will be required.

However, if one of the covered species becomes delisted during the period covered by this consultation, reinitiation is not required. Those portions of the biological opinion referring to that species will become defunct and implementation of any proposed conservation measures or required reasonable and prudent measures and terms and conditions would no longer be necessary.

Minor changes to portions of a biological opinion can also be accomplished through amendment of the opinion. Given the uncertainty of many aspects of the proposed action and the specifics of measures to be taken, it is anticipated that several amendments to the biological opinion will occur over the 25-year time period. However, given the court's position on the earlier amendments to the 1994 biological opinion, the Service will limit amendments to clarification of specifics and other minor adjustments. Amendments should not include any changes that significantly alter the effects to the species considered in the opinion.

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APPENDIX 1. Acronyms Used in the Document

ADES = Arizona Department of Economic Security

ADWR = Arizona Department of Water Resources

AGFC = Arizona Game and Fish Commission

AGFD = Arizona Game and Fish Department

ASU = Arizona State University

BLM = Bureau of Land Management

CAP = Central Arizona Project

CAWCD = Central Arizona Water Conservation District

ch = critical habitat

COE = U.S. Army Corp of Engineers

CWA = Clean Water Act

DDE = dichlorophenyl-dichloroethylene

DDT = dichloro-diphenyl-trichloroethane

DFRT = Desert Fishes Recovery Team

EA = environmental assessment

EIS = environmental impact statement

ESA = Endangered Species Act

FAO = Food and Agriculture Organization of the United Nations

FONSI = finding of no significant impact

GIS = geographic information system

GRIC = Gila River Indian Community

INLAA = is not likely to adversely affect

NEPA = National Environmental Policy Act

NMGF = New Mexico Game and Fish Department

RPA = reasonable and prudent alternative (of a jeopardy biological opinion)

SAWRSA = Southern Arizona Water Rights Settlement Act

SCIDD = San Carlos Irrigation and Drainage District

SCIP = San Carlos Irrigation Project

SOL = U.S. Department of the Interior Solicitors

SOW = scope of work

TASRI = Tucson System Reliability Investigations

TNC = The Nature Conservancy

USBR = U.S. Bureau of Reclamation

USFWS = U.S. Fish and Wildlife Service

USFS = U.S. Forest Service

USGS = U. S. Geological Survey

APPENDIX 2. Scientific Names of Species

African clawed frogs *Xenopus laevis*

Alewife *Alosa pseudoharengus*

Alligator snapping turtle *Macroclemys terminckii*

American alligator *Alligator mississippiensis*

American shad *Alosa sapidissima*

Anchor worm *Lernea cyprinacea*

Apache trout *Oncorhynchus apache*

Arizona cliffrose *Purshia (*formerly *Cowania) subintegra*

Arizona hedgehog cactus *Echinocereus triglochidiatus* var. *arizonicus*

Arctic grayling *Thymallus arcticus*

Asian clam *Corbicula manilensis* [=*fluminea*]

Asian tapeworm *Bothriocephalus acheilognathi*

Atlantic salmon *Salmo salar*

Bald eagle *Haliaeetus leucocephalus*

Beautiful shiner *Cyprinella formosa*

Bermuda grass *Cynodon dactylon*

Big-ear radix *Radix auricularia*

Bighead carp *Aristichthys nobilis*

Bigmouth buffalo *Ictiobus cyrinellus*

Bigscale logperch *Percina macrolepida*

Bitterling *Rhodeus sericeus*

Black buffalo *Ictiobus niger*

Black bullhead *Ameiurus melas*

Black carp *Mylopharyngodon piceus*

Black crappie *Pomoxis nigromaculatus*

Blue catfish *Ictalurus furcatus*

Bluegill *Lepomis macrochirus*

Blue tilapia *Tilapia (=Oreochromis) aurea*

Bonytail *Gila elegans*

Brackish water shrimp - genus and species unknown

Brazilian waterweed *Egeria densa*

Brook trout *Salvelinus fontinalis*

Brown bullhead *Ameiurus natalis*

Brown trout *Salmo trutta*

Bullfrog *Rana catesbeiana*

Cactus ferruginous pygmy owl *Glaucidium brasilianum cactorum*

Central stoneroller *Campostoma anomalum*

Channel catfish *Ictalurus punctatus*

Chinese mystery snail *Cipangopaludina chinensis malleatus*

Chiricahua leopard frog *Rana chiricahuensis*

Chytrid fungus *Batrochytrium dendrobatidis*

Clear Lake splittail *Pogonichthys ciscoides*

Colorado squawfish *Ptychocheilus lucius*

Common carp *Cyprinus carpio*

Common snapping turtle *Chelydra serpentina*

Convict cichlid *Cichlasoma nigrofasciatum*

Copepod (no common name) *Pseudocaligus* sp.

Cottonwood *Populus* spp.

Curly pondweed *Potamageton crispus*

Cutthroat trout *Oncorhynchus clarki*

Darters *Etheostoma*, *Ammocrypta*, *Percina* spp.

Desert pupfish *Cyprinodon macularius*

Desert sucker *Pantosteus clarki*

Dotted duckweed *Spirodela punctata*

Emerald shiner *Notropis atherinoides*

Eurasian water-milfoil *Myriophyllum spicatum*

European frog-bit *Hydrocharis morsus-ranae*

Everglades crayfish *Procambarus alleni*

False map turtle *Graptemys pseudographica*
Fathead minnow *Pimephales promelas*
Firemouth cichlid *Cichlasoma meeki*
Flannelmouth sucker *Catostomus latipinnis*
Flathead catfish *Pylodictis olivaris*
Fountain darter *Etheostoma fonticola*
Fountain grass *Pennisetum setaceum*
Freshwater shrimp probably *Palaemonetes* spp.
Ghost rams-horn *Biomphalaria havanensis*
Giant freshwater prawn probably *Palaemonetes* sp.
Giant marine toads *Bufo marinus, Bufo horribilis,* and *Bufo paracnemis*
Giant rams-horn snail *Marisa cornuarietis*
Giant salvinia *Salvinia molesta*
Gila chub *Gila intermedia*
Gila topminnow *Poeciliopsis occidentalis occidentalis*
Gila trout *Oncorhynchus gilae*
Gizzard shad *Dorosoma cepedianum*
Golden shiner *Notemigonus chrysoleucus*
Golden trout *Oncorhynchus aguabonita*
Goldfish *Carassius auratus*
Grass carp *Ctenopharyngodon idella*
Green sunfish *Lepomis cyanellus*
Green swordtail *Xiphophorus helleri*
Guppy *Poecilia reticulata*
Hitch *Lavinia exilicauda*
Huachuca springsnail *Pyrgulopsis thompsoni*
Huachuca water umbel *Lilaeopsis schaffneriana* var. *recurva*
Humpback chub *Gila cypha*
Hydrilla *Hydrilla verticillata*
Ide *Leuciscus idus* and *Idus idus*
Inland silversides *Menidia beryllina*
Juniper *Juniperus* spp.
Koi *Cyprinus carpio*
Kokanee (sockeye salmon) *Oncorhynchus nerka*
Lake trout *Salvelinus namaycush*
Lake whitefish *Coregonus clupeaformis*
Largemouth bass *Micropterus salmoides*
Lesser long-nosed bat *Leptonycteris curasoae yerbabuenae*
Little Colorado spinedace *Lepidomeda vittata*
Loach minnow *Tiaroga cobitis*
Longfin dace *Agosia chrysogaster*
Longjaw mudsucker *Gillichthys mirabilis*
Louisiana crayfish probably *Procambarus clarkii*
Lowland leopard frog *Rana yavapaiensis*
Mexican wolf *Canis lupus baileyi*
Mitten crab *Eriocheir sinensis*
Monkey Springs pupfish *Cyprinodon* sp.
Mosquitofish (eastern) *Gambusia holbrooki*
Mosquitofish (western) *Gambusia affinis*
Mozambique mouthbrooder or tilapia *Oreochromis mossambicus*
New Zealand mudsnail *Potamopyrgus antipodarum*
Nichol's turkshead cactus *Echinocactus horizonthalonius* var. *nicholii*
Nile mouthbrooder or tilapia *Oreochromis niloticus*
Northern crayfish *Orconectes virilis*
Northern pike *Esox lucius*
Opossum shrimp *Mysis relicta*
Oriental snail - see red rim melania
Oriental weatherfish *Misgurnus anguillicaudatus*
Oscar *Astronotus ocellatus*
Osprey *Pandion haliaeetus*
Pacu *Colossoma* spp.
Paper pondshell *Anodonta imbecilis*

Parrot feather *Myriophyllum aquaticum*
Pecos pupfish *Cyprinodon pecosensis*
Peregrine falcon *Falco peregrinus anatum*
Pike topminnow or killifish *Belenesox belizanus*
Pima pineapple cactus *Coryphantha scheeri* var. *robustispina*
Pink salmon *Oncorhynchus gorbuscha*
Pinyon pine *Pinus* spp.
Piranha *Serraselmus* spp.
Plains killifish *Fundulus zebrinus*
Ponderosa pine *Pinus ponderosa*
Pumpkinseed *Lepomis gibbosus*
Quagga mussel *Dreissena bugensis*
Rabbit's foot grass *Polypogon monspeliensis*
Rainbow smelt *Osmerus mordax*
Rainbow trout *Oncorhynchus mykiss*
Razorback sucker *Xyrauchen texanus*
Red-belly tilapia *Tilapia zillii*
Redear sunfish *Lepomis microlophus*
Red rim melania *Melanoides tuberculatus*
Red shiner *Cyprinella lutrensis*
Redside shiner *Richardsonius balteatus*
Red swamp crayfish *Procambarus clarki*
Rio Grande cichlid *Cichlasoma cyanoguttatum*
Rio Grande leopard frog *Rana berlandieri*
Rio Grande sucker *Catostomus (Pantosteus) plebius*
Roach *Rutilus rutilus*
Rock bass *Ambloplites rupestris*
Round goby *Neogobius melanostomus*
Roundtail chub *Gila robusta*
Rudd *Scardinius erythrophthalmus*
Ruffe *Gynocephalus cernus*
Rusty crayfish *Orconectes rusticus*
Sacramento blackfish *Orthodon microlepidotus*
Sacramento perch *Archoplites interruptus*
Sailfin molly *Poecilia latipinna*
Salt cedar *Tamarix* spp.
Sanborn's long-nosed bat - see lesser long-nosed bat
Sculpins *Cottus* spp.
Sheepshead minnow *Cyprinodon variegatus*
Shortfin molly *Poecilia mexicana*
Shortnose gar *Lepisosteus platostomus*
Silver carp *Hypophthalmichthys molitrix*
Silver dollarfish *Metynnis roosevelti*
Slider (including red-eared) *Trachemys scripta*
Smallmouth bass *Micropterus dolomeiu*
Smallmouth buffalo *Ictiobus bubalus*
Snakehead *Canna canna*
Snapping turtle *Chelydra serpentina*
Sonora sucker *Catostomus insignis*
Sonora tiger salamander *Ambystoma tigrinum stebbinsi*
Southwestern willow flycatcher *Empidonax traillii extimus*
Speckled dace *Rhinichthys osculus*
Spectacled caiman *Caiman crocodilus*
Spikedace *Meda fulgida*
Spiny softshell turtles *Trionyx spiniferus*
Spiny water flea *Bythotrephes* sp.
Spotted bass *Micropterus punctulatus*
Spotted metynnis *Metynnis* spp.
Stonewort *Nitellopsis obtusa*
Striped bass *Morone saxatilis*
Suckermouth catfish *Hypostomus* sp.
Swamp eel *Monopterus albus*
Sycamore (Arizona) *Platanus wrightii*
Tench *Tinca tinca*
Thornber's fishhook cactus *Mammilaria thornberi*

Threadfin shad *Dorosoma petenense*

Tiger salamander *Ambystoma tigrinum*

Tilapia *Tilapia spp., Oreochromis spp.*

Trematode (no common name) *Gyrodactylus turnbulli*

Tubificid worm (no common name) *Branchiura sowerbyi*

Tumamoc globeberry *Tumamoca macdougalii*

Variable platyfish *Xiphophorus variatus*

Walking catfish *Clarias batrachus*

Walleye *Stizostedion vitreum*

Wami tilapia *Oreochromis urolepis*

Warmouth *Chaenobryttus gulosus*

Water cress *Rorippa nasturtium aquaticum*

Water hyacinth *Eichhornia crassipes*

Water lettuce *Pistia stratiotes*

Water monitor *Varanus salvator*

Western painted turtle *Chrysemys picta*

White bass *Morone chrysops*

White crappie *Pomoxis annularis*

White perch *Morone americanus*

White River springfish *Crenichthys baileyi*

White sucker *Catostomus commersoni*

Willow *Salix* spp.

Woundfin *Plagopterus argentissimus*

Yaqui catfish *Ictalurus pricei*

Yaqui chub *Gila purpurea*

Yaqui topminnow *Poeciliopsis occidentalis sonoriensis*

Yellow bass *Morone missisippiensis*

Yellow bullhead *Ameirus natalis*

Yellow floating heart *Nymphoides peltata*

Yellow grub *Clinostomum marginatum*

Yellow perch *Perca flavescens*

Yellow sweet clover *Melilotus indicus*

Yuma clapper rail *Rallus longirostris yumanensis*

Zebra mussel *Dreissena polymorpha*

Zooplankton (no common name) *Daphnia lumholtzi*

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-83-F-10	Central Arizona Water Control Study - Plan 6	F	3/8/83 amended 4/7/83	jeopardy nonjeopardy	bald eagle Yuma clapper rail Gila topminnow peregrine falcon
	- Waddell Dam	F	11/15/84 amended 7/2/97	jeopardy	bald eagle
	- Cliff Dam	F	8/15/85	jeopardy	bald eagle
	- Cliff Dam	F	3/10/87	nonjeopardy	Arizona cliffrose
	- Roosevelt Dam (see also 2-21-95-F-462)	F	3/30/90	jeopardy	bald eagle
2-21-83-I-24	New Waddell Pumped Storage Hydroelectric Plant	I		file missing	
2-21-83-I-50	Pump below Granite Reef Dam	I			bald eagle Yuma clapper rail
2-21-83-I-55	CAP upstream water exchange (converted to 2-21-86-F-87)	I	see 2-21-86-F-87		spikedace loach minnow bald eagle

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-22-83-F-74	Upper Gila Water Supply Study (Hooker/Connor Dam)	F	draft 3/9/87	nonjeopardy	spikedace loach minnow bald eagle
2-21-84-F-49	Ft. McDowell Indian Reservation Rehabilitation and Betterment Irrigation System	F	3/21/85	jeopardy	bald eagle
2-21-84-I-56	Tucson Aqueduct Phase B (CAP)	C F	11/18/85 6/27/86	jeopardy jeopardy	Tumamoc globeberry Thornber’s fishhook cactus Tumamoc globeberry
2-21-84-I-92	Tonopah Irrigation District - CAP water delivery system	I			none
2-21-84-F-96	Southern Arizona water rights settlement act, Papago and San Xavier Indian Reservations (SAWRSA) and Schuk Toak	F	11/2/87	nonjeopardy	Tumamoc globeberry
2-21-84-I-97	Granite Reef aqueduct wildlife water catchments	I		no effect	peregrine falcon

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-84-I-98	Avra Valley Irrigation and Drainage District delivery system (CAP)	I			Thornber's fishhook cactus
2-21-85-I-03	Farmers investment cooperative - CAP water system	I			bald eagle peregrine falcon Thornber's fishhook cactus
2-2185-I-38	Cave Creek Water company storage facility	I			none
2-21-85-I-40	Salt River Indian Community Plan - CAP	I			bald eagle peregrine falcon Yuma clapper rail
2-21-85-I-41	Papago Chui Chu on-reservation delivery system - CAP	I			Yuma clapper rail Thornber's fishhook cactus
2-21-85-I-66	Castle Hot Springs right-of-way rerouting	I			none
2-21-85-I-106	Queen Creek, Chandler Heights, San Tan Irrigation Districts delivery systems - CAP	I			none
2-21-86-I-22	Ft. McDowell Irrigation Project	I			bald eagle peregrine falcon Yuma clapper rail

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-86-I-27	City of Tucson treatment plant, reservoir and delivery pipeline (CAP)	I		no effect	Thornber's fishhook cactus Tumamoc globeberry
2-21-86-I-35	Delivery system CAP - Community Water Company of Green Valley, Green Valley Water Company, and New Pueblo Water Company	I			bald eagle peregrine falcon Tumamoc globeberry Thornber's fishhook cactus
2-21-86-I-66	Relocation and reconstruction of US 88 near Government Camp on Lake Roosevelt	I		file missing	
2-21-86-I-73	Gila River Indian Community water and soil conservation study (CAP)	I			Thornber's fishhook cactus Tumamoc globeberry
2-21-86-C-87 2-21-86-F-87	Upper Gila Water Supply Study and Verde River diversions	C F	4/14/86 5/30/90 amended 3/18/94	jeopardy & adverse modification jeopardy &adverse modification of proposed critical habitat	spikedace loach minnow spikedace

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-87-I-52	Pan Quemado communication site and road (CAP)	I			Tumamoc globeberry Thornber's fishhook cactus Nichol's turkshead cactus
2-21-87-I-56	High Plains States groundwater recharge demonstration project in Arizona	I			Tumamoc globeberry
2-21-87-I-79	Temporary 69KV line and substation, New Waddell Dam	I			bald eagle peregrine falcon
2-21-87-I-90	Water resources core hole drilling, Tohono O'odham	I			Tumamoc globeberry Nichol's turkshead cactus Thornber's fishhook cactus
2-21-87-I-124	Tucson Aqueduct Reach 6 or Tucson Pipeline/Tunnel	I			Tumamoc globeberry
2-21-88-I-71	New powerplant road and Apache Trail relocation, Roosevelt Dam	I			none
2-21-88-I-72	Proposed wildlife water catchments, New Waddell Dam	I			none
2-21-88-I-113	Los Reales transmission line, CAP	I		no effect	Tumamoc globeberry

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-88-I-125	Doe Peak water catchments, New Waddell Dam	I			none
2-21-89-I-34	Wildlife water catchments, Tucson aqueduct	I			Tumamoc globeberry
2-21-89-I-36	Wildlife water catchments, Salt-Gila aqueduct	I			none
2-21-89-I-101	Wildlife water catchments, Pinal County	I			none
2-21-90-I-41	Tucson water treatment plant spoil site	I		no effect	Tumamoc globeberry
2-21-90-I-51	Pasqua Yaqui Reservation	I			Tumamoc globeberry Sanborn's bat Gila topminnow
2-21-90-F-119	Pima Lateral Feeder Canal/Introduction and Spread of nonnative species into Gila River Basin (excluding the Santa Cruz) via CAP	F F (reinitiation)	4/20/94 amended 6/22/95 5/6/98 7/15/98 1/13/00 6/30/00 4/ /01	jeopardy & adverse modification jeopardy nonjeopardy	spikedace loach minnow razorback sucker Gila topminnow bald eagle Colorado squawfish desert pupfish

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-90-I-151	Carefree Water Company upgrade	I			none
2-21-91-I-238	CAP - Salt River Pima-Maricopa Indian Community water use	I		no effect	bald eagle Yuma clapper rail
2-21-91-F-248	Federal Loan Application, Fort McDowell Indian Reservation	F	2/28/92	jeopardy	bald eagle
2-21-91-I-406	Tucson Aqueduct System Reliability (TASRI) - Construction and Filling of reservoir	F	2/11/98	jeopardy	Pima pineapple cactus
		I			Gila topminnow lesser long-nosed bat desert pupfish cactus ferrug. pygmy owl
	- CAP Nonnative Introduction and Spread in Santa Cruz River subbasin	F	draft 6/11/99	jeopardy	Gila topminnow
		I	12/6/94	no effect	spikedace loach minnow razorback sucker Colorado squawfish
			6/5/97	is not likely to adversely affect	Sonora tiger salamander Chiricahua leopard frog

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-92-I-41	Salt River siphon, Granite Reef Dam	I		not likely to adversely affect	bald eagle Yuma clapper rail razorback sucker bonytail chub
2-21-92-I-226	Pima Mine Road pilot recharge project	I			lesser long-nosed bat Tumamoc globeberry
2-21-92-I-709	Cacti salvage at Lake Pleasant	F	formal withdrawn 12/3/92		bald eagle
2-21-92-I-722	San Carlos Irrigation District Rehabilitation for CAP	I			none
2-21-93-I-86	Gila River Indian Community on-farm development	I			bald eagle SW willow flycatcher peregrine falcon Yuma clapper rail cactus ferrug. pygmy owl lesser long-nosed bat
2-21-93-I-124	Sierra Vista wastewater wetlands (converted to 2-21-99-I-097)	I	see 2-21-99-I-097		

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-93-I-339	Cortaro-Marana Irrigation District indirect recharge project	I		no effect with proposed mitigation and time limit, renewed for 1995	spikedace loach minnow Gila topminnow desert pupfish razorback sucker Colorado squawfish bald eagle
2-21-93-I-412	New River siphon repairs	I			bald eagle peregrine falcon
2-21-95-I-247	Agua Fria siphon repairs	I			peregrine falcon cactus ferrug. pygmy owl
2-21-95-I-248	Avondale Multi-purpose constructed wetlands and recharge project	I		no adverse effect	Yuma clapper rail peregrine falcon cactus ferrug. pygmy owl
2-21-95-F-462	Roosevelt Lake, water level changes	F	7/17/96 amended 6/7/99	jeopardy	SW willow flycatcher
2-21-96-I-136	City of Surprise recharge project	I			unknown

APPENDIX 3. Central Arizona Project – Section 7 Consultation History

CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES
2-21-97-214	Marana High Plains Effluent Recharge Project	I		no effect	SW willow flycatcher cactus ferrug. pygmy owl
2-21-97-F-314	CAP water assignment Camp Verde and Cottonwood	F	3/30/98 amended 4/28/98	nonjeopardy	razorback sucker SW willow flycatcher Arizona cliffrose
2-21-99-I-097	San Pedro River watershed effluent recharge project	I	1/25/99	is not likely to adversely affect	Huachuca water umbel peregrine falcon SW willow flycatcher
2-21-99-I-190	Construction of San Xavier CAP-Link pipeline	F	5/13/99 amended 5/26/99	nonjeopardy	Pima pineapple cactus
2-21-99-F-360	Central Avra Valley storage and recharge project	F			cactus ferrug. pygmy owl
2-21-00-I-115	Water exchange agreement between BHP Copper and Tonto Hills Utility Company	I		no effect	AZ hedgehog cactus cactus ferrug. pygmy owl

APPENDIX 3. Central Arizona Project – Section 7 Consultation History					
CONSULTATION NUMBER	PROJECT	FORMAL(F)/ INFORMAL(I)/ CONFERENCE(C)	BIOLOGICAL OPINION/ CONCURRENCE DATE	FINDING	SPECIES

TOTALS

Total informals plus formals - 67

Biological opinions - 18
jeopardy/adv.mod. - 11
nonjeopardy - 4
Pending - 2
Withdrawn - 1

Draft biological opinions - 2
jeopardy/adverse mod. - 1
nonjeopardy - 1

Conference reports - 2
jeopardy/adverse mod. - 2
nonjeopardy - 0

INLAA concurrences - 2

Consultation numbers abandoned - 2

Other informals - 43

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin (Excluding the Santa Cruz Subbasin)	
DATE	EVENT
	1986
April 11, 1986	Memo; Service to Reclamation stating no threatened, endangered or proposed species located within proposed Pima Lateral Canal project site
October 1986	Draft EA for Pima Lateral Feeder Canal
	1989
July 21, 1989	Field trip; Reclamation, Service, AGFD, and SCIP to examine potential for nonnative fish to enter Gila River from CAP through Pima Lateral Feeder Canal and discuss electric barrier installation on Pima Lateral Feeder Canal
August 11, 1989	Memo; Reclamation to Service discussing nonnative fish problem on Pima Lateral and stating Reclamation's intent to continue informal consultation on bald eagle and listed fish
August 24, 1989	Letter; AGFD to Service expressing concern about nonnative fish moving from CAP into the Gila River through the Pima Lateral Canal and recommending protective barriers for Aravaipa Creek and the upper San Pedro River
August 28, 1989	Memo; Service to Reclamation – update of Planning Aid Report for Pima Lateral Feeder Canal discussing concern for nonnatives from CAP to reach Gila River
October 1989	Final EA and FONSI for Pima Lateral Feeder Canal
October 13, 1989	Memo; AGFD to Reclamation expressing concern about nonnative fish moving from CAP into the Gila River through the Pima Lateral and other SCIP canals
	1990
January 29, 1990	Memo; Service to Reclamation agreeing to interim water deliveries through the Pima Lateral Feeder Canal if electric barriers are in place on Pima Lateral Feeder Canal and with commitment for a study, monitoring, and contingency control of nonnative fish
February 28, 1990	Memo; Reclamation to Service agreeing to conditions for interim water deliveries through the Pima Lateral Feeder Canal and that informal consultation "will suffice for 1990 interim CAP water service contracts"
March 14, 1990	Meeting; Reclamation and Service to discuss interim CAP water deliveries to SCIDD through 5 additional turnouts with construction of additional electric barrier at China Wash on Florence-Casa Grande Canal
March 1990	EA for 1990 interim water deliveries of CAP water to SCIDD
March 20, 1990	Species list; Service to Reclamation for CAP water deliveries to Pima Lateral Feeder Canal and other turnouts to the Florence-Casa Grande Canal system; included bald eagle, loach minnow and spikedace

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
April 1990	Pima Lateral Feeder Canal electric barrier placed into operation
April 6, 1990	Letter; AGFD to Reclamation concurring with SCIDD interim deliveries with electric barrier at China Wash
May 1990	China Wash (Florence-Casa Grande Canal) barrier placed into operation
summer 1990	Reclamation, Service, and AGFD develop SOW and Reclamation lets contract for study of potential for fish transfer from CAP
	1991
February 1991	Report by W.J. Matter on Potential for Transfer of Non-native fish in Central Arizona Project Canal Waters to the Gila River System
February 12, 1991	Biological Assessment; Reclamation to Service on Possible impacts to federally listed endangered species for the CAP due to the transfer of nonnative fish, concluding the project may affect, but is not likely to adversely affect, bald eagle, spikedace, and loach minnow, but requesting a biological opinion by March 1
February 14, 1991	Memo; Service to Reclamation acknowledging receipt of request for formal consultation and agreeing to deliver biological opinion within 90 days
May 7, 1991	Meeting; consultation team of experts meets to provide assistance on biological opinion
May 14, 1991	Meeting; Reclamation and Service, agreeing (among other things) to add Gila topminnow to consultation, but to separate the Santa Cruz River subbasin consultation from the consultation on the rest of the Gila River basin
May 20, 1991	Letter; Reclamation to CAWCD acknowledging that interim delivery of water to SCIP, SCIDD, and GRIC had occurred in violation of mitigation agreement and instructing that no further deliveries should be made
May 21, 1991	Memo; Reclamation to Service granting extension for biological opinion until June 1, 1991
May 29, 1991	Letter; Dr. W.L. Minckley to Service clarifying comments on threat to native fish from CAP introduction and spread of nonnatives
May 30, 1991	Draft biological opinion; Service to Reclamation on transportation and delivery of CAP water to the Gila river basin in AZ and NM concluding jeopardy to spikedace, loach minnow, Gila topminnow, and razorback sucker and nonjeopardy to bald eagle, Colorado squawfish, and desert pupfish
June 28, 1991	Memo; Reclamation to Service, review of draft biological opinion
July 25, 1991	Meeting; Reclamation and Service, staff and management (field and regional) to discuss Reclamation's concerns about draft biological opinion and provide economic and technical feasibility information
August 21, 1991	Meeting; Reclamation and Service, to discuss and refine RPA
September 12, 1991	Memo; Reclamation to Service, discussing progress on RPA and that agreement at staff level is not likely

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
October 8, 1991	Memo; Service to Reclamation, recommending continued staff level discussion of RPA
October 10, 1991	Meeting; Reclamation and Service staff and management (field and regional) discussing jeopardy call and RPA
October 23, 1991	Federal Register final rule; listing razorback sucker as an endangered species
October 23, 1991	Memo; Reclamation to Service, requesting extension of consultation until December 31, 1991
November 12, 1991	Meeting; Reclamation and Service, staff and management (field and regional) discussing jeopardy call and RPA needs
December 17, 1991	Meeting; Reclamation and Service, discussing RPA
December 24, 1991	Memo; Reclamation to Service, requesting extension of consultation to February 28, 1992
	1992
January 29, 1992	Meeting; Reclamation and Service discussing RPA
February 7, 1992	Memo; Reclamation to Service, requesting permission to discontinue operation of Pima Lateral Feeder Canal and China Wash electric barriers during water year 1992
February 25, 1992	Memo; Service to Reclamation, stating that operation of the electric barriers should continue at all times when there is water present on the barriers
February 26, 1992	Memo; internal Reclamation, documenting previously-unknown presence of spikedace in middle Gila River just upstream from Ashurst-Hayden Dam
March 13, 1992	Memo; Reclamation to Service, new proposal for RPA and extending consultation date until May 28, 1992
April 9, 1992	Memo; SCIP to Service, notifying that they intend to cease operation of Pima Lateral Feeder Canal electric barrier despite Service's February 25, 1992 memo of disagreement
May 15, 1992	Memos; SCIP to Reclamation and Service, notifying of cessation of operation of the Pima Lateral Feeder Canal electric barrier, as of May 1
June 2, 1992	Meeting; Reclamation and Service staff, discussing RPA
June 18, 1992	Meeting; Reclamation and Service management, discussing RPA
June 29, 1992	Memo; Reclamation to Service, documenting extension of consultation period to August 26, 1992
August 31, 1992	Memo; Service to Reclamation, extending the consultation to September 25, 1992
October 25, 1992	Meeting; Reclamation and Service staff, discussing draft BO version dated September 25, 1992

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin (Excluding the Santa Cruz Subbasin)	
DATE	EVENT
December 14, 1992	Meeting; Reclamation and Service staff, discussing draft RPA
	1993
January 25, 1993	Meeting; Reclamation and Service staff, discussing RPA
February 12, 1993	Meeting; Reclamation and Service staff, discussing RPA
March 12, 1993	Meeting; Reclamation and Service staff, discussing RPA
April 9, 1993	Meeting Reclamation and Service staff, discussing RPA
April 20, 1993	Meeting, Reclamation and Service staff, discussing RPA
May 6, 1993	Meeting; Reclamation and Service staff, discussing RPA
May 11, 1993	Revised draft biological opinion sent to Reclamation and Service Regional Offices for review
May 20, 1993	Meeting; Reclamation and Service management, discussing revised draft biological opinion
September 17, 1993	Memo; Reclamation to Service, requesting concurrence with additional interim CAP water deliveries to SCIP and GRIC
September 21, 1993	Memo; Service to Reclamation, agreeing to finding of no effect from additional interim CAP water deliveries to SCIP and GRIC with conditions
September 26, 1993	Notice of intent to pursue legal action; Maricopa Audubon Society to Service and Reclamation, re CAP and nonnative species with violations of the ESA
October 7, 1993	Meeting; Reclamation and Service staff and management, discussing revised draft biological opinion
December 22, 1993	Meeting; Reclamation and Service, discussing RPA revisions
December 27, 1993	Revised draft RPA sent to Regional Office by Service
	1994
January 5, 1994	Revised draft RPA sent to Regional Office by Reclamation
January 20, 1994	Notice of intent to pursue legal action; Earthlaw to Reclamation, re CAP and nonnative species with violations of the ESA
February 8, 1994	Letter; AGFD to Service objecting to Reclamation assuming native and nonnative management roles and requesting that any such funding be given to AGFD
February 15, 1994	Memo; Service Regional Office to Field Office with permission to proceed with RPA, May 1993 version

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
February 22, 1994	Meeting; Reclamation and Service management, discussing various issues, including the CAP and nonnatives consultation
March 2, 1994	Memo; Reclamation to Service, requesting final biological opinion on the transportation and delivery of CAP water to the Gila River Basin, with May 1993 RPA version
March 8, 1994	Federal Register final rules; designation of critical habitat for spikedace and loach minnow
April 15, 1994	Final biological opinion on the transportation and delivery of CAP water to the Gila River basin in AZ and NM
April 20, 1994	Memo; Service to Reclamation, transmitting April 15, 1994 biological opinion
July 30, 1994	Meeting; Reclamation and Service with Aravaipa Creek Homeowner's Association, to discuss fish barriers
July 30, 1994	Notice of intent to pursue legal action; SW Center for Biological Diversity, re April 15, 1994 biological opinion on transportation and delivery of CAP water to the Gila River basin
August 5, 1994	Letter; Reclamation to GRIC, permission to resume CAP water deliveries to GRIC
August 26, 1994	Meeting; Reclamation, Service, and interested parties, discussing fish barriers for Aravaipa Creek and San Pedro River
August 30, 1994	Memo; Reclamation to Service, accepting April 15, 1994 biological opinion on transportation and delivery of CAP water to the Gila River basin and discussing need for extensions of time on some RPA elements
August 31, 1994	Meeting; Reclamation, Service, SOL, discussing funding transfer mechanisms for 1994 RPA
September 8, 1994	Letter; Reclamation to CAWCD, permission to resume CAP water deliveries to GRIC and SCIDD
September 15, 1994	Meeting; Reclamation, Service, and AGFD, discussing AGFD objections to RPA implementation by other than State
September 28, 1994	Meeting; Reclamation, Service, and species experts, generation of ideas for use of RPA element 3 and 4 funds
October 24, 1994	Meeting; Reclamation, Service, AGFD, and NMGF to discuss RPA implementation
	1995
February 8, 1995	Meeting; Reclamation and Service, discussing RPA implementation and need for extensions of due dates for funding transfer and monitoring plan and field work
March 8, 1995	Letter; Reclamation to AGFD, opposing stocking of nonnative arctic grayling, in compliance with conservation recommendations of April 15, 1994 biological opinion

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
April 13, 1995	Memo; Service to Reclamation, concurrence that additional consultation is not needed for Aravaipa barrier construction and recommending that the COE be added to April 15, 1994 biological opinion as a joint action agency
May 22, 1995	Meeting; Reclamation, Service, and interested parties, discussing fish monitoring protocol
May 1995	Rebuttal report to April 15, 1994 biological opinion on transportation and delivery of CAP water to the Gila River basin; prepared by CAWCD
June 8, 1995	Letter; CAWCD to Service and Reclamation, requesting that consultation be reinitiated on CAP and nonnative species issues in Gila River basin and Notice of Intent to pursue legal action
June 22, 1995	Memo; Service to Reclamation, list of projects for RPA elements 3 and 4, year 1 funds
June 22, 1995	Amendment 1 to April 15, 1994 biological opinion extending monitoring protocol to June 1, 1995, (with interim monitoring) and RPA 3 and 4 first funding transfers to June 30, 1995,
June 29, 1995	Letter; ADWR to Dept. of Interior, requesting reinitiation of section 7 consultation on CAP nonnative species issues in Gila River basin
July 2, 1995	Draft fish monitoring plan (protocol) send out for review by Reclamation
July 12, 1995	Notice of Intent to sue; Snell and Wilmer for CAWCD, on April 15, 1994 biological opinion on transportation and delivery of CAP water in the Gila River basin
August 15, 1995	Letter; Service to CAWCD, reply to May 1995 rebuttal report and negative reply to June 12, 1995 letter requesting the Service and Reclamation reinitiate consultation on CAP and nonnative species issues in the Gila River basin
August 25, 1995	Meeting; Service and Reclamation, discussing NEPA and CWA 404 needs for fish barriers
August 31, 1995	Memo; Service to Reclamation, species list for construction of Aravaipa Creek fish barriers
September 5, 1995	Meeting; Reclamation, Service, and AGFD, discussing AGFD concerns about RPA elements 3 and 4 and Federal implementation of actions the State believes are their prerogatives
September 22, 1995	Meeting; Reclamation, Service, CAWCD, and SOL, discussing CAWCD's objections to the April 15, 1994 biological opinion
September 26, 1995	Letter, AGFD to Reclamation, setting up policy and technical committees to oversee implementation of the RPA
October 4, 1995	Meeting; Reclamation, Service, CAWCD, discussing opportunities to minimize cost of RPA
October 13, 1995	Meeting; Reclamation, Service, CAWCD, discussing opportunities to minimize cost of RPA and need for extension on fund transfer and information and education

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(Excluding the Santa Cruz Subbasin)

DATE	EVENT
October 1995	Monitoring of fish begins
November 27, 1995	Letter; AGFD to Reclamation, disputing Reclamation's authority to monitor fish and requesting that Reclamation fund AGFD to conduct the required RPA monitoring
December 11, 1995	Meeting; Reclamation, Service, and CAWCD, discussing CAWCD role and costs in implementation of April 15, 1994 biological opinion
December 14, 1995	Letter; Reclamation to AGFD, agreeing to establishment of Policy and Technical Committees to oversee RPA implementation
	1996
January 26, 1996	Memo; Service to BLM, discussing concerns about fish barriers on San Pedro River and Aravaipa Creek
January 31, 1996	Meeting; CAP RPA Policy Committee
March 22, 1996	Meeting; CAP RPA Policy and Technical Committees
May 3, 1996	Memo; Service to Reclamation, discussing concepts and strategies for RPA element 3 and 4 funds
May 23, 1996	Meeting; CAP RPA Policy Committee
June 12, 1996	Revised draft fish monitoring plan (protocol) send out for review by Reclamation
June 13, 1996	Letter; Aravaipa Property Owners Association to Dept. of Interior, protesting fish barriers on Aravaipa Creek
July 2, 1996	Memo; Reclamation to Service, revised and expanded project descriptions for year 1 projects under RPA elements 3 and 4
August 6, 1996	Public meeting; held by Reclamation to discuss San Pedro River fish barriers
August 21, 1996	Meeting; Reclamation, Service, interested parties, discussing Aravaipa Creek fish barriers
October 1996	Long-term monitoring plan for fish populations in selected waters of the Gila River basin, Arizona, revision no. 2
December 18, 1996	Meeting; Reclamation, Service, BLM, discussing Aravaipa Creek and San Pedro River fish barriers
	1997
February 1, 1997	Meeting; Reclamation, Service, and Aravaipa Property Owners Assoc., discussing Aravaipa Creek fish barriers
February 26, 1997	Memo; BLM to Reclamation, rejecting request to allow survey for potential barriers sites on the upper San Pedro River in the San Pedro Riparian National Conservation Area

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
February 1997	Congressional restrictions on use of Reclamation funds to implement April 15, 1994 biological opinion
March 7, 1997	Lawsuit complaint filed by Earthlaw for SW Center for Biological Diversity; re April 15, 1994 biological opinion on transportation and delivery of CAP water to the Gila River basin
April 2, 1997	Letter; Aravaipa Property Owners Assoc. to Senator McCain, protesting Aravaipa Creek fish barriers
April 16, 1997	E-mails; Reclamation to Service, reporting new records of nonnative goldfish and white bass from CAP aqueduct
April 17, 1997	E-mail; Reclamation to Service, reporting new record of nonnative black bullhead from CAP aqueduct
May 19, 1997	Meeting; Reclamation, Service, AGFD, and ASU, discussing videos for information and education element of RPA
June 1997	Report; fish monitoring relative to impacts of the CAP in the Gila River basin, Arizona: results of the winter 199607 field season
July 14, 1997	Lawsuit complaint; CAWCD, re April 15, 1994 biological opinion on transportation and delivery of CAP water in the Gila River basin
August 18, 1997	Meeting; Reclamation and Service, discussing Aravaipa and San Pedro barriers
August 21, 1997	Intra-agency agreements; fund transfers Reclamation to Service, RPA elements 3 and 4 - year 1 funds
September 1997	Congressional restrictions on use of Reclamation funds to implement April 15, 1994 biological opinion
October 9, 1997	Telephone record; Reclamation to Service, reporting new record of bluegill from upper San Pedro River
October 15, 1997	E-mail; internal to Service, documenting verbal extension of time on Aravaipa Creek barriers until sometime in 1999, to be determined at progress meetings in March and August 1998
October 17, 1997	Memo; Reclamation to Service, requesting extension of time for Aravaipa Creek fish barriers
October 30, 1997	Telephone record; CAWCD to Service, seeking concurrence with stocking of nonnative black carp into CAP aqueduct, and discussing Service opposition
November 26, 1997	Modification 1 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA elements 3 and 4, changing technical representative
	1998
January 16, 1998	E-mail; Reclamation to Service, reporting new record of nonnative black crappie and threadfin shad in Gila River
January 27, 1998	Letter; Reclamation to AGFD, request for AGFD assistance in information and education element of RPA

APPENDIX 4. Consultation History for the Central Arizona Project - Nonnative Introduction and Spread in the Gila River Basin
(Excluding the Santa Cruz Subbasin)

DATE	EVENT
January 29, 1998	Memo: Reclamation to Service, recommendation for hiring an independent technical monitor for RPA element 3 and 4 implementation
February 11, 1998	Meeting; CAP RPA Technical Committee
March 3, 1998	Meeting; Reclamation and Service, regarding possible Redfield Canyon fish barrier, in compliance with conservation recommendations of the April 15, 1994 biological opinion
March 16, 1998	Meeting; Reclamation, Service, Natural Resources Conservation District, discussing barriers on the San Pedro River
March 17, 1998	Memo; Reclamation to BLM, requesting support of BLM for construction of fish barrier in Redfield Canyon, as part of implementation of conservation recommendations of the April 1994 biological opinion
March 24, 1998	Progress report; Reclamation to Service, on construction of fish barriers on Aravaipa Creek
March 25, 1998	Federal Register final rule; revocation of critical habitat for spikedace, loach minnow, and Mexican spotted owl
March 26, 1998	Letter; Service to Smallhouse, regarding possible endangered species concerns on his property if he grants and easement for fish barriers
March 1998	Report; Reclamation, Results of fish monitoring of selected waters of the Gila River Basin, 1995-1996
May 6, 1998	Amendment 2 to the April 15, 1994 biological opinion; extending due dates for the Aravaipa Creek barriers to December 31, 1999 and removing consideration of critical habitat for spikedace and loach minnow
May 26, 1998	Meeting; Reclamation, Service, and The Nature Conservancy, discussing San Pedro River fish barriers
June 12, 1998	Meeting; CAP RPA Technical Committee
June 17, 1998	Letter; COE to Service, requesting to be added to April 15, 1994 biological opinion as a joint agency for the purposes of the CWA section 404 permits for the Aravaipa and San Pedro barriers
June 19, 1998	Biological assessment; Reclamation to Service, concluding no effect to SW willow flycatcher, cactus ferruginous pygmy owl, lesser-long-nosed bat, peregrine falcon, bald eagle, and Chiricahua leopard frog from construction of Aravaipa Creek fish barriers
June 26, 1998	Memo; Service to Reclamation, accepting cooperating agency status of NEPA for Aravaipa Creek fish barriers
June 27, 1998	Public scoping meeting; for NEPA on Aravaipa Creek fish barriers
July 10, 1998	Meeting; CAP RPA Technical Committee
July 15, 1998	Amendment 3 to the April 25, 1994 biological opinion; adding COE as a joint consulting agency for the purpose of CWA 404 permitting for fish barriers

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DATE	EVENT
July 27, 1998	Memo; Service to Reclamation, agreeing that no Fish and Wildlife Coordination Act report is needed for Aravaipa Creek fish barriers
August 21, 1998	Draft EA for construction of fish barriers on Aravaipa Creek
September 17, 1998	Application for CWA section 404 permit for Aravaipa Creek fish barriers
September 21, 1998	Meeting; CAP RPA Technical Committee
November 25, 1998	Final EA for construction of fish barriers on Aravaipa Creek
December 3, 1998	Meeting; Reclamation, Service, AGFD, BLM, DFRT, finalizing design concept for Aravaipa Creek fish barriers
December 14, 1998	Memo; Reclamation to Service, requesting extension of time for Aravaipa Creek and San Pedro River fish barriers
	1999
January 4, 1999	Meeting; Reclamation and Service, discussing Aravaipa barriers and San Carlos Apache and BIA concerns
March 1, 1999	Meeting; CAP RPA Technical Committee
March 3, 1999	Progress report; Service to Reclamation, implementation of RPA elements 3 and 4 of the April 1994 biological opinion
March 5, 1999	Modification 2 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA elements 3 and 4, year 2 funds
June 4, 1999	Memo; Reclamation to Service, expressing concerns that RPA element 3 and 4 funds are not being expended fast enough
August 3, 1999	Meeting; CAP RPA Technical Committee
August 1999	Report; results of fish monitoring of selected waters of the Gila River basin, 1997
September 24, 1999	Federal Grant; Reclamation to AGFD, for development of information and education program on nonnative aquatic species
September 30, 1999	Court order denying CAWCD’s complaint on April 15, 1994 biological opinion
November 2, 1999	Meeting; Reclamation and Service, discussing Reclamation’s concerns that Service is not expending RPA element 3 and 4 funds fast enough
November 4, 1999	Amendment 4 to the April 15, 1994 biological opinion; extending due date for Aravaipa fish barrier to June 30, 2000 and the San Pedro fish barrier to April 15, 2001

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DATE	EVENT
December 10, 1999	Federal Register proposed rule; proposed designation of critical habitat for spikedace and loach minnow
	2000
January 13, 2000	Memo; Service to Reclamation, discussing newly proposed critical habitat for spikedace and loach minnow and concluding conferencing is not needed
February 14, 2000	E-mail; reporting new record for nonnative black bullhead in Gila River, bluegill in the Gila Giver, and sailfin mollies in the Salt River
March 1, 2000	Letter; AGFD to Reclamation, transmitting summary tables for fish monitoring from Oct. 12, 1999 through January 7, 2000
April 6, 2000	Progress report; Reclamation to Service, on implementation of fish barriers and requesting for amendment of due dates for Aravaipa and San Pedro barriers
April 11, 2000	Modification 3 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA elements 3 and 4, year 3 funds
April 25, 2000	Federal Register final rule; designation of critical habitat for spikedace and loach minnow
May 8, 2000	Progress report; Service to Reclamation, implementation of RPA elements 3 and 4 of the April 1994 biological opinion
May 19, 2000	Meeting; CAP RPA Technical Committee
June 22, 2000	Memo; Reclamation to Service, request for reinstatement of the 1994 critical habitat findings for spikedace and loach minnow and requesting opinion on how delays in RPA 3 and 4 fund transfers have affected jeopardy removal
June 14, 2000	Meeting; CAP RPA Technical Committee
June 30, 2000	Amendment 5 to April 15, 1994 biological opinion; extending due dates on Aravaipa barriers to November 1, 2000 and on San Pedro barriers to July 1, 2002, with contingency provision for Hot Springs Canyon barrier to replace one San Pedro barrier, also making finding that the CAP will not adversely modify critical habitat for spikedace and loach minnow, and concluding that delays in funding transfers did not alter the removal of jeopardy
July 28, 2000	Meeting; CAP RPA Technical Committee
August 4, 2000	Modification 4 to the Intra-agency agreement; fund transfer Reclamation to Service, RPA element 4, passing funds to Reclamation for action on certain projects

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DATE	EVENT
September 18, 2000	Modification 4 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA element 3, passing funds back to Reclamation for action on certain projects Modification 5 to the Intra-agency agreement -fund transfers Reclamation to Service, RPA element 4, passing funds back to Reclamation for contracting specific projects
September 22, 2000	Court order denying in part the SW Center for Biological Diversity regarding the April 15, 1994 biological opinion and ordering reinitiation of consultation
October 2000	Informal consultation on reinitiation begins with telephone and other informal discussions
November 3, 2000	Memo; Reclamation to Service, request for reinitiation of April 1994 section 7 consultation on transportation and delivery of CAP water to the Gila River basin, with no biological assessment provided
November 20, 2000	Letter; CAWCD to Reclamation, requesting applicant status for reinitiated consultation
November 21, 2000	Memo; Service to Reclamation, rejecting request for reinitiation of consultation and identifying required information that must be provided
December 4, 2000	Letter; Reclamation to CAWCD, granting applicant status for reinitiated consultation on transportation and delivery of CAP water to the Gila River basin
December 13, 2000	Court order denying injunction to SW Center for Biological Diversity
December 15, 2000	Letter; Reclamation to GRIC, granting applicant status for reinitiated consultation on transportation and delivery of CAP water to the Gila River basin
December 19, 2000	Modification 5 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA element 3, year 4 funds Modification 6 to the Intra-agency agreement; fund transfers Reclamation to Service, RPA element 4, year 4 funds
	2001
January 3, 2001	Biological assessment and request for reinitiation of consultation; Reclamation to Service, re transportation and delivery of CAP water in the Gila River basin
January 19, 2001	Meeting; Reclamation and Service staff, discussing revised project description for reinitiation of consultation and possible additional “mitigation” needs
January 29, 2001	Memo; Reclamation to Service, re request for issuance of draft biological opinion on the reinitiated consultation on transportation and delivery of CAP water to the Gila River basin, AZ and NM
January 31, 2001	Meeting; Reclamation and Service staff, discussing revised project description for reinitiation of consultation and possible additional “mitigation” needs

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DATE	EVENT
February 6, 2001	Memo; Service to Reclamation, re acknowledgment of reinitiation of formal section 7 consultation on the transportation and delivery of CAP water to the Gila River basin in AZ and NM and its potential to introduce and spread nonnative aquatic species
February 7, 2001	Meeting; Reclamation and Service staff and management (field offices), discussing revised project description for reinitiation of consultation and possible additional “mitigation” needs
February 7, 2001	Memo; Service to Reclamation, re electric barrier ineffectiveness and the need for new solutions
February 13, 2001	Letter; Service to CAWCD, requesting information on use of grass carp in CAP aqueduct
February 20, 2001	Meeting; Reclamation and Service staff and management (field offices), discussing revised project description for reinitiation of consultation and possible additions to project description
February 27, 2001	Letter; CAWCD to Service, re scope of reinitiated consultation on delivery of CAP water through the Pima Lateral Feeder Canal
March 1, 2001	Letter; CAWCD to Service, objections to Service’s request for information on stocking of grass carp in CAP aqueduct
March 2, 2001	Meeting; Reclamation and Service with AGFD and NMGF, briefing on status of reconsultation and possible additions to “mitigation”
March 2, 2001	Meeting; Reclamation and Service with CAWCD and GRIC, discussing status of reconsultation and possible additions to “mitigation”
March 2-15, 2001	Telephone calls; Reclamation and Service Regional Directors, negotiation of conservation measures and retroactive Service overhead for year 4 of recovery and nonnative management funds
March 5-15, 2001	Telephone calls; Reclamation and Service management and staff, negotiation of conservation measures and Service overhead
March 6, 2001	E-mail; Service to Reclamation, informal draft of consultation history for review
March 16, 2001	Memo; Reclamation to Service, additional components to be incorporated into the project description for the reconsultation on transportation and delivery of CAP water to the Gila River basin
March 20, 2001	E-mail; informal draft of project description section for draft biological opinion for review
March 16-22, 2001	Telephone calls; between Reclamation and Service, re information on project history and features and discretion of Reclamation in CAP
March 26, 2001	Telephone call; Service to Reclamation staff, possible incidental take statement provisions for bald eagle and Chiricahua leopard frog
March 27, 2001	Meeting; Service and Reclamation, removal of Chiricahua leopard frog from this consultation to separate conference report and incidental take statement provisions for bald eagle

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DATE	EVENT
March 27, 2001	E-mail; Reclamation to Service, comments on draft project description section for draft biological opinion
April 3, 2001	Memo; Service to Reclamation, transmitting draft biological opinion for review
April 3, 2001	Letters; Service to CAWCD, GRIC, and SW Center for Biological Diversity, transmitting draft biological opinion for review
April 9, 2001	Memo; Reclamation to Service, transmitting comments on draft biological opinion and comments of GRIC
April 9, 2001	Letter; CAWCD to Service, response to draft biological opinion
April 9, 2001	E-mail; SW Center for Biological Diversity, transmitting comments on draft biological opinion
April 13, 2001	Letter; CAWCD to Service, transmitting comments on draft biological opinion
April 17, 2001	Memo; Service to Reclamation, transmitting final biological opinion and background document

APPENDIX 5. Actions Discussed for Possible Inclusion in the Conservation Measures, Reasonable and Prudent Alternatives, or Terms and Conditions, and the Rationale for Rejection

The following alternative actions were discussed between Reclamation and the Service for possible inclusion in the proposed conservation measures. For a variety of reasons, as given below, these actions were not included in the final conservation measures.

PHYSICAL INFRASTRUCTURE (barriers, etc.)

1. Set "enforceable" due dates for fish barriers. This was a recommendation of the Center for Biological Diversity in October 2000. The concept was to set dates that would be legally enforceable by a private party. This was rejected because a private party already has the right to sue if a barrier due date, as set in the biological opinion, is missed, thus potentially changing the outcome of the action. In addition, other legal obligations of the Federal government may alter the ability of Reclamation to adhere strictly to dates in the conservation measures.

2. Consider use of fish screens or filters on CAP aqueduct turnouts or on outflows of CAP water into the Gila River. This was also a Center for Biological Diversity recommendation. Screens and filters to downstream movement of species have been looked at for feasibility several times (see 1994 biological opinion). Each time, they have been rejected because, in most circumstances, their effectiveness is low and maintenance would be expensive and time consuming.

3. Replace the electrical barriers with rotating drum screens. This was strongly considered, but was rejected because use of a new technology would present a whole new suite of unanticipated problems that would need to be worked out over time. Reclamation and the Service agreed that it would be better to fix the existing barriers than to replace them with something new.

4. Replace the electrical barriers with ozonation stations to sterilize the water. This was rejected because the technology for use of ozone in open water is undeveloped and of questionable potential.

5. Retain the proposed paired fish barriers on the San Pedro River. This was rejected in favor of a barrier on the San Pedro and one on either Hot Springs Canyon or Redfield Canyon, both tributaries of the San Pedro. While this option decreases protection for the mainstem San Pedro, it provides for protection of a stream into which spikedace and loach minnow from Aravaipa Creek can be replicated.

6. Construct no fish barriers on the San Pedro River. This was rejected because the Service strongly believes there is substantial potential for recovery of several listed fish in the San Pedro

River. Failure to construct a barrier to CAP introduced and spread nonnative fish would make it likely that the San Pedro River could never support repatriated populations of listed fish due to increasing nonnative impacts.

7. Construct barriers that would prevent upstream movement of non-fish nonnatives. No known technology exists to construct such barriers.

8. Rebuild Ashurst-Hayden and Granite Reef Dams to make them complete fish barriers. This was rejected because the dams do not belong to Reclamation and it is not within their authority to require such reconstruction. Reclamation has suggested that the question of rebuilding Ashurst-Hayden might be better dealt with through the upcoming negotiations over use of the GRIC CAP settlement allocation.

9. Include a fish barrier on the mainstem Agua Fria River. This was rejected because the expense and technical difficulty of such a barrier is not justified by the amount of listed species resources at risk upstream. The resources would be better expended elsewhere, where a greater benefit to the listed species could be achieved.

10. Include a fish barrier on a stream which would be suitable for replication of Blue River loach minnow. This was rejected because the need for a replicate stream for Blue River loach minnow may exist within the Blue River drainage, where it would be protected by the mainstem Blue River barrier. Although protection of a second replicate stream would be desirable, it was of lesser priority than the streams selected to be included in the conservation measures.

11. Include a fish barrier on the East Fork White River. This was rejected because we do not know if the White Mountain Apache Tribe would agree to such a barrier and this consultation did not allow the time for coordination with the Tribe, as required by Secretarial Order 3206. In addition, although such a barrier is desirable, it is of lesser priority than the streams selected for inclusion in the conservation measures.

12. Construct a massive gravel filter at the intake of the CAP at Lake Havasu. This was rejected because it would be very expensive and the technology is unclear at this time.

MONITORING

1. Include a monitoring station for nonnative fish on the lower Verde River. Although this station would be desirable, it may or may not provide a level of information sufficiently greater than that already being gathered; thus justifying the additional expense. It was, therefore, included in the conservation recommendations as a discretionary action.

2. Include non-fish nonnatives in the monitoring program. This could be very difficult and expensive due to the wide variety of species that may be involved. Because of questions

regarding the feasibility, this was not included in the terms and conditions, but was placed into the discretionary conservation recommendations.

3. Monitor bald eagle reproductive productivity. This was rejected because it was uncertain how the information could be related to effects of nonnative species introduced or spread via CAP.

4. Monitor bald eagle prey remains to detect new nonnative species. This was not included because the level of effects and/or take to bald eagle from CAP are not considered of enough magnitude to justify such a requirement.

ACTIONS FOR MANAGEMENT AGAINST NONNATIVES

1. Take action to remove red shiner from Aravaipa Creek. This was a Center for Biological Diversity recommendation. It was rejected because the adverse consequences to spikedace, loach minnow and the Aravaipa Creek ecosystem of such a removal operation would outweigh the benefits at this time.

2. Sterilization of CAP aqueduct water, using ozone or chlorine. This was considered in the 1994 consultation and was reconsidered here. Use of ozone was rejected because it would still be prohibitively expensive and the technology to treat such a large volume of water is not available. Use of chlorine would also have technical difficulties in addition to human health hazards.

3. Include in the conservation measures the 1994 conservation recommendation for opposition to new nonnatives in lower Colorado River waters under Reclamation control. This was not specifically rejected and is included in the 2001 biological opinion as a conservation recommendation.

FUNDING FOR MANAGEMENT AGAINST NONNATIVES AND RECOVERY IN-LIEU OF THREAT REMOVAL

1. Transfer $1.5 million from Reclamation to the Service to “catch up” on funds for which the transfer was delayed for 3 years. This was a recommendation of the Center for Biological Diversity. This was rejected because such a transfer would be of no benefit to the listed species. Reclamation and the Service are moving forward on expenditure of the funds already transferred, and an additional $1.5 million could not be spent rapidly in any meaningfully effective manner that would benefit the listed species.

2. Retention by Reclamation of the funding, and administration, of one or both of the nonnative management and recovery programs. This was rejected due to concerns about authority, expertise, cost, infrastructure, and duplication of ongoing programs.

3. Retain the 1994 provision for no Reclamation or Service overhead from management against nonnatives and recovery funding. This was rejected due to new Service policy requiring such funds to be subject to overhead charges.

4. Freeze Service overhead charges at 4.5% for all monies transferred under the conservation measures. This was rejected due to new Service policy, which requires varying amounts of overhead dependent upon how the funds will be used.

5. Replace the recovery funds with specified actions, to be taken by Reclamation, that would contribute to recovery. This was rejected in favor of retaining the existing funding transfers.

6. Establishment of escrow funds. This was called for in the 1994 biological opinion, but has been stymied by legal and policy questions. It was rejected for the conservation measures and was replaced by a provision that funding for emergency nonnative control needs would be made available out of annual funds that were awaiting obligation. Establishment of a trust account, into which the entire lump sum of the remaining 2 years' funding would be placed, was also considered. This avenue will continue to be explored, but would require Congressional authorization. Use of the Fish and Wildlife Foundation to administer the funds was also considered and also will continue to be explored.

7.   Provide for an annual increase in the nonnative management and recovery funds to adjust for inflation. Also considered was a one-time lump sum increase to cover the inflation from 1994 to 2001. This was rejected because of the uncertainty as to the extent of the Reclamation commitment.

8. Increase the amount of funding for the nonnative management and recovery programs. This was partially incorporated, in the increase to cover Service overhead charges. Additional increases were rejected in favor of a greater investment in barrier construction.

9. Increase the amount of nonnative management funding to cover future implementation of alternative nonnative species control techniques that may be developed under the existing funding. This was rejected because it is not predictable which of the new techniques being explored will prove to be useable, nor what implementation of such techniques would cost.

INFORMATION AND EDUCATION

1. Extend the information and education program for additional years. This was not included because it was not considered necessary to removal of the potential for jeopardy and/or adverse modification of critical habitat.

GENERAL

1. Increase the number of years over which the conservation measures are to be continued. The 25 year period called for in the 1994 biological opinion (4 years now already implemented) was based on the time-to-recovery estimates of the spikedace and loach minnow recovery plans. Although it has become clear that those were significant underestimates, the option to increase the time period for the conservation measures was rejected. If the species covered in the consultation, and for which CAP might pose jeopardy or adverse modification of critical habitat, are delisted prior to, or at, the 25 year point, then the issue of conservation measure implementation for that species becomes moot. If, at the end of the 25 years, some of the species remain listed and the CAP is still thought to pose a threat to those species, then reinitiation of consultation will be necessary.

2. Incorporate the 1994 reasonable and prudent alternative into the conservation measures without changes. This was rejected because there is new information on the effectiveness of implementation of reasonable and prudent alternative elements, on the level of threat from no-fish nonnatives, on the status of the listed species, and other factors. This new information indicated that some changes in, and additions to, the 1994 reasonable and prudent alternative were needed.