United States Department of the Interior

U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

12/17/07

In Reply Refer to:

AESO/SE
22410-2006-F-0224

December 12, 2007

Email Transmission
Memorandum

To: Area Manager, Boulder Canyon Operations Office, Bureau of Reclamation, Boulder City, Nevada

From: Field Supervisor

Subject: Final Biological Opinion for the Proposed Adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Thank you for your request for formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). We received your request, dated September 10, 2007, on September 12, 2007. At issue are impacts that may result from the proposed adoption of the Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead in Coconino and Mohave counties, Arizona, and Clark County, Nevada. The proposed action may affect humpback chub (*Gila cypha*) and its critical habitat, Kanab ambersnail (*Oxyloma haydeni kanabensis*), and southwestern willow flycatcher (*Empidonax traillii extimus*) and its critical habitat.

You also requested our concurrence that the proposed action is not likely to adversely affect the Yuma clapper rail (*Rallus longirostris yumaensis*), woundfin (*Plagopterus argentissimus*) and its critical habitat, Virgin River chub (*Gila seminuda*) and its critical habitat, bonytail (*Gila elegans*), razorback sucker (*Xyrauchen texanus*) and its critical habitat, the Colorado pikeminnow (*Ptychocheilus lucius*) and its critical habitat, and southwestern willow flycatcher and its critical habitat (in the Muddy and Virgin river geographic portions of the action area). You also requested our concurrence that the proposed action is not likely to adversely affect the candidate western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and that the proposed action will have no effect to the endangered Moapa dace (*Moapa coriacea*). We concur with Reclamation's determinations and have provided our rationales in Appendix A of this biological opinion.

This biological opinion is based on information provided in your September 10, 2007, biological assessment, the February 2007 draft and November 2007 final environmental impact statements (U.S. Bureau of Reclamation 2007a, 2007b; collectively referred to here as the EIS), subsequent exchanges of information with the Bureau of Reclamation, and other sources of information. Literature cited in this biological opinion is not a complete bibliography of all literature available on the species of concern, dam operations and its effects, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at our office.

In keeping with our trust responsibilities to American Indian Tribes, we have provided for participation of the BIA in this consultation and, by copy of this biological opinion, are notifying the following Tribes of its completion: the Ak-Chin Indian Community, Chemehuevi Indian Tribe, Cocopah Tribe, Colorado River Indian Tribes, Fort McDowell Yavapai Nation, Fort Mohave Indian Tribe, Gila River Indian Community, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, Pascua Yaqui Tribe, Fort Yuma Quechan Tribe, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, San Juan Southern Paiute Tribe, Tohono O Odham Nation, Tonto Apache Resevation, White Mountain Apache Tribe, Yavapai Apache Nation, Yavapai Prescott Indian Tribe, and Pueblo of Zuni.

Introduction

The proposed action for this biological opinion consists of the Bureau of Reclamation's (Reclamation) implementation of the Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead (Guidelines). The Guidelines will be implemented from December 2008 through September 2026; the interdependent/interrelated action of creation and delivery of conserved water from the Muddy and Virgin rivers by Southern Nevada Water Authority (SNWA), which is also covered in this biological opinion, will be implemented for a 50-year period. The Guidelines would remain in effect for determinations to be made through water year 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP).

All elements of the proposed action within the geographic area of the Colorado River from Lake Mead to Mexico constitute "covered actions" covered by the 2005 Biological and Conference Opinion on the Lower Colorado River Multi-Species Conservation Program (MSCP) and are encompassed within the boundaries of the MSCP planning area (FWS 2005a), and thus effects of these actions are not further addressed here. We formally documented this determination in a memorandum to you dated November 26, 2007. The upper boundary of the MSCP is defined as elevation 1,229 feet above mean sea level (msl), the full pool elevation of Lake Mead, and is located at approximately Grand Canyon River Mile 235 (RM, as defined in Stevens 1983).

The proposed action for Glen Canyon Dam as defined in this biological opinion does not include monthly, daily, and hourly operations of the dam. With respect to this proposed

action, the fundamental decision regarding Glen Canyon Dam establishes the annual volume of release during the proposed interim period. In addition, Glen Canyon Dam is operated in accordance with Reclamation's 1996 Record of Decision (ROD). The requirements stipulated in the ROD serve as the baseline (i.e. current conditions) for this proposed action in the Lake Powell to Lake Mead reach. This reach was not addressed in the MSCP and thus no Act coverage from the MSCP applies upstream of Lake Mead. The range of releases and operational constraints covered by the ROD is described in Table 1.

Reclamation's current operational approach has a minimum objective release of 8.23 maf annually from Glen Canyon Dam. The proposed action would allow Reclamation to change these operations by allowing for potential annual releases less than the minimum objective release under certain, identified conditions. However, even in years with an annual release less than 8.23 maf, daily and hourly releases would continue to be made according to the parameters of the ROD, which would not be affected by the proposed Federal action.

On November 13, 2007, Reclamation requested reinitiation on certain flow-related actions regarding Reclamation's operation of Glen Canyon Dam; the precise elements that will be the subject of the reinitiation of consultation will be defined in Reclamation's forthcoming Biological Assessment, but will not in any manner modify the annual release volumes that are the subject of this Biological Opinion. The daily and monthly operations of Glen Canyon Dam continue to be defined by the ROD and are included in the Environmental Baseline for this consultation.

The Glen Canyon Dam Adaptive Management Program (AMP) was established in 1997 to comply with the Grand Canyon Protection Act of 1992 (GCPA), the 1995 Operation of Glen Canyon Dam Final Environmental Impact Statement (1995 EIS), and the ROD, and provides a process for assessing the effects of current operations of Glen Canyon Dam on downstream resources and using the results to develop recommendations for modifying dam operations and other resource management actions. This is accomplished through the Adaptive Management Work Group (AMWG), a Federal advisory committee. The AMWG consists of stakeholders that are Federal and State resource management agencies, representatives of the seven Basin States, Indian Tribes, hydroelectric power marketers, environmental and conservation organizations, and recreational and other interest groups. The duties of the AMWG are in an advisory capacity only, but recommendations of the AMWG are conveyed by the Secretary's Designee to the Secretary of the Interior and play an important role in the decisions of the Department of the Interior. Coupled with this advisory role are long-term monitoring and research activities that provide a continual record of resource conditions and new information to evaluate the effectiveness of the operational modifications to Glen Canyon Dam and other management actions, including actions undertaken to conserve Act-listed species.

The AMP consists of the following major components:

- The AMWG, a Federal advisory committee that makes recommendations on how to adjust the operation of Glen Canyon Dam and other management actions to fulfill the obligations of the GCPA.

- The Secretary of the Interior's Designee that serves as the chair of the AMWG and provides a direct link between the AMWG and the Secretary of the Interior.

- The Technical Work Group (TWG) which translates AMWG policy into information needs, provides questions that serve as the basis for long-term monitoring and research activities, and conveys research results to AMWG members.

- The U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center (GCMRC), which provides scientific information on the effects of the operation of Glen Canyon Dam and related factors on natural, cultural, and recreational resources along the Colorado River between Glen Canyon Dam and Lake Mead.

- The independent review panels (IRPs), which provide independent assessments of the program to ensure scientific validity. Academic experts in pertinent areas make up a group of Science Advisors (SAs).

Consultation History

Specific events related to this consultation are presented below.

- Throughout 2007 – We met with Reclamation several times and conducted numerous telephone conversations in preparation of the EIS and to discuss specific aspects of the proposed action as they relate to this consultation.

- January 19 and September 14, 2007 – We submitted formal comments on administrative drafts of the EIS.

- July 9, 2007 – We met with Reclamation and SNWA to discuss potential effects of the proposed action, and we agreed to provide a final biological opinion by December 2007.

- July 12 and August 11, 2007 – We received draft versions of the biological assessment.

- July 26 and August 23, 2007 – We submitted informal comments on the draft versions of the biological assessment.

- September 12, 2007 – We received a final biological assessment. Also in September, we had several conversations with Reclamation regarding potential conservation measures for listed species relative to the proposed action.

- November 2, 2007 – Reclamation published a final EIS.

- November 2, 2007 – We met with SNWA to discuss implementation of their interdependent and interrelated action of storage and delivery of conserved water in the Muddy and Virgin rivers.

- October 26, 2007 – We received a memorandum from Reclamation requesting confirmation that all elements of the proposed action within the geographic area of the Colorado River from Lake Mead to Mexico constitute "covered actions" covered by the 2005 Biological and Conference Opinion on the MSCP (MSCP BCO).

- November 26, 2007 – We sent a memorandum to Reclamation acknowledging that all elements of the proposed action within the geographic area of the Colorado River from Lake Mead to Mexico constitute "covered actions" covered by the MSCP BCO.

- December 3, 2007 – We sent a draft biological opinion to Reclamation.

- December 6, 2007 – We received comments on our draft biological opinion from Reclamation.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The proposed action will take place on the Colorado River from Lake Powell to the international border with Mexico, and in general concerns how water will be delivered through this reach of the river (specifically via the Guidelines) for the period from December 2008 through September 2026. The Guidelines would remain in effect for determinations to be made through water year 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the AOP. The Guidelines include a coordinated operation of Lake Powell and Lake Mead, designed to minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin. They also provide a mechanism, called Intentionally Created Surplus (ICS), for promoting water conservation in the Lower Basin. The Guidelines have four operational elements that collectively are designed to address shortages and coordinated operations for Lake Powell and Lake Mead and will be used by the Secretary to:

1. Determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million-acre-feet (maf) (a "Shortage") pursuant to Article II(B)(3) of the United States Supreme Court in the case of Arizona v. California, 547 U.S. (2006) (Consolidated Decree);

2. Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;

3. Allow for the storage and delivery, pursuant to applicable Federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water-use needs from Lake Mead (ICS), particularly under drought and low reservoir conditions; and

4. Determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed Federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 FR 7772), and the term of the ISG from 2016 to 2026.

The proposed action is comprised of three distinct geographic segments:

1. Lake Powell and the Colorado River from Glen Canyon Dam to the upper end of Lake Mead (primarily related to operational element 2, coordinated reservoir operations);

2. The full length of the Muddy River in Nevada and the Virgin River from the Mesquite Diversion near Mesquite, Nevada, to Lake Mead (primarily related to operational element 3, storage and delivery mechanism [ICS]);

3. The Colorado River from Lake Mead to the Southerly International Boundary with Mexico (related to operational element 1, shortage determinations; operational element 2, coordinated reservoir operations; operational element 3, storage and delivery mechanism; and operational element 4, ISG). Operational elements in this geographic segment constitute "covered actions" covered by the MSCP BCO, are encompassed within the boundaries of the MSCP planning area, and are not addressed further in this biological opinion.

The four operational elements for the proposed action are further defined as follows:

Element 1: Lower Basin Shortage Determinations

The proposed action provides discrete levels of shortage associated with specific Lake Mead elevations, such that:

- When Lake Mead is projected to be below elevation 1,075 msl and at or above 1,050 feet msl on January 1, a shortage of 333 thousand acre feet (kaf) shall be declared for that year;

- When Lake Mead is projected to be below elevation 1,050 feet msl and at or above 1,025 feet msl on January 1, a shortage of 417 kaf shall be declared for that year;

- When Lake Mead is projected to be below elevation 1,025 feet msl on January 1, a shortage of 500 kaf shall be declared for that year; and

- When Lake Mead is below elevation 1,025 feet msl, the Secretary shall undertake appropriate consultation, including with the seven Colorado River Basin States (Basin States; Wyoming, Colorado, New Mexico, Arizona, California, Nevada, and Utah), to discuss further measures that may be undertaken consistent with the Law of the River.

The shortage element constitutes "covered actions" covered by the MSCP BCO (FWS 2005a) that are encompassed within the boundaries of the MSCP planning area, and are not addressed further in this biological opinion.

Element 2: Coordinated Reservoir Operations

Under the proposed action, the annual Lake Powell release is based on a volume of water in storage or corresponding elevation in Lake Powell and Lake Mead as described below.

Equalization

The proposed action provides Lake Powell Equalization Elevations (Table 2) that would be used in determining when equalization releases would be made. When the projected January 1 Lake Powell elevation is at or above these specified elevations and when the volume of Lake Powell is projected to be greater than the volume of Lake Mead at the end of the water year, Lake Powell would release greater than 8.23 million acre feet per year (mafy) to equalize its volume with Lake Mead such that the release does not cause Lake Powell to be below the Equalization Elevation at the end of the water year. Provided however if Lake Powell reaches the Equalization Elevation and the projected-end-of-water year elevation of Lake Mead is below 1,105 feet msl, additional releases from Lake Powell would be made until the first of the following conditions is projected to occur at the end of the water year: (i) Lake Powell and Lake Mead are equalized; (ii) Lake Mead reaches 1,105 feet msl; or (iii) Lake Powell reaches 20 feet below the Equalization Elevation.

Upper Elevation Balancing

When the projected January 1 Lake Powell elevation is below the Equalization Elevation and at or above 3,575 feet msl, a release in the amount of 8.23 maf from Lake Powell would be made if the projected January 1 Lake Mead elevation is at or above 1,075 feet msl. If the projected January 1 Lake Mead elevation is below 1,075 feet msl, the contents of Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 7.0 maf.

If the April projection of the Lake Powell end-of-water year elevation is above the Equalization Elevation, the Lake Powell release would be according to Equalization as described above.

If the April projection of the Lake Mead end-of-water year elevation is less than 1,075 feet msl and the Lake Powell end-of-water year elevation is at or above 3,575 feet msl, the contents of Lake Mead would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.0 maf and no less than 8.23 maf.

Mid-Elevation Releases

When the projected January 1 Lake Powell elevation is below 3,575 feet msl and at or above 3,525 feet msl, a release in the amount of 7.48 maf would be made if the projected January 1 Lake Mead elevation is at or above 1,025 feet msl. If the projected January 1 Lake Mead elevation is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

Lower Elevation Balancing

When the projected January 1 Lake Powell elevation is below 3,525 feet msl, Lake Mead and Lake Powell would be balanced if possible, within the constraint that the release from Lake Powell would not be more than 9.5 maf and no less than 7.0 maf.

Element 3: Storage and Delivery of Conserved Water

The proposed action includes the adoption of a mechanism (ICS) to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining, system efficiency improvements, and tributary conservation. The ICS mechanism provides for creating credits for the conserved or imported water and delivering the water at a later date.

The volumes of ICS activity that are assumed for each State and other entities (shown as "Additional Amounts") are presented in Table 3. At this time, it is unknown exactly which entities might participate in the ICS mechanism. Furthermore, the timing and magnitude of the conservation and subsequent delivery of conserved water is unknown. In order to analyze the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead, it was assumed that conservation would originate from a point on the river within each State located furthest downstream with respect to ICS activities within that State. Similarly, conservation within the Additional Amounts category was assumed to originate in Mexico in order to disclose the maximum effects of the mechanism to reservoir storage and river flows below Lake Mead.

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS mechanism would benefit the system through a Lake Mead system assessment. At the time the ICS credits are created, 5 percent of the ICS credits would be dedicated to the system on a one-time basis. Additionally, ICS credits would be subject to annual evaporation losses of 3 percent per year. If flood control releases occur, ICS credits would be reduced on a pro-rata basis among all holders of ICS credits until no credits remain.

Under the assumptions made for the analysis contained herein, the maximum amount of ICS credits that can be created during any year, the maximum cumulative amount of ICS credits that can be available at any one time, and the maximum amount of ICS credits that may be recovered in any one year under the proposed action are presented in Table 3.

Upon adoption of the proposed action, the maximum cumulative amount of ICS credits that can be available at any one time will be 2.1 maf. This amount could be increased up to 4.2 maf in future years during the interim period. The expansion of the ICS mechanism in the future would be based on operational experience gained during implementation of the proposed action.

The effects of creation and delivery of ICS from Lake Mead are covered by the MSCP BCO (FWS 2005a), that is encompassed within the boundaries of the MSCP planning area and is not addressed further in this biological opinion.

Element 4: Interim Surplus Guidelines

The proposed action includes both a modification and an extension of the existing ISG currently in place through 2016. The ISG would be extended through 2026 and be modified by eliminating the Partial Domestic Surplus Condition, beginning in 2008, and limiting the amount of water available under the Full Domestic Surplus Condition during the period 2017 through 2026. These modifications reduce the amount of surplus water that could be made available and leaves more water in storage to reduce the frequency and severity of future shortages.

Associated Actions

Storage and Delivery of Conserved Water by Southern Nevada Water Authority

The SNWA intends to allow water in the Muddy and Virgin rivers, historically diverted from those rivers for agricultural and municipal use, to remain in the rivers. Such water will flow downstream to be captured in and diverted from Lake Mead as part of the ICS feature of the proposed action. The mechanism to allow for creating, storage and delivery of conserved water in Lake Mead does not currently exist, thus, SNWA would not be able to perform this activity absent adoption of the proposed action. Therefore, routing the additional Virgin and Muddy river flows downstream to Lake Mead is considered part of the proposed action as an interdependent action.

The SNWA proposed project would allow pre-Boulder Canyon Project Act of 1929 (BCPA) water rights on the Virgin and Muddy rivers to be retired from their current use (historically diverted from the Virgin and Muddy rivers for agricultural and municipal use) and would cause the water secured by SNWA through this process to flow into Lake Mead for crediting and delivery for municipal and industrial purposes. A separate assessment of the potential effects of SNWA's proposed project to listed, proposed, and candidate species was included as Attachment B in the biological assessment (U.S. Bureau of Reclamation 2007c). Because Reclamation determined that the proposed action would adversely affect southwestern willow flycatcher in the Lake Powell to Lake Mead geographical areas of the proposed action, and that the proposed action in the Virgin and Muddy rivers would not adversely affect the species in that part of its range, effects of the proposed action on southwestern willow flycatchers are analyzed both as part of this biological opinion and in our concurrences in Appendix A to this biological opinion.

Attachment B to the biological assessment states that "the conveyance of SNWA's water rights can be flexible, based on the irrigation company operating requirements and wildlife needs. To accommodate these needs, the water rights may be diverted at different places or during different times of the year" (U.S. Bureau of Reclamation 2007c). We met with SNWA on November 2, 2007, to discuss that flexibility with regard to fish and wildlife needs along the Virgin River. SNWA agreed to work cooperatively with us as part of the implementation of the proposed Federal action to provide for improved conditions, where possible and in coordination with necessary operations for existing irrigation companies, which can contribute to the recovery of the Virgin River listed species. This includes the commitment to explore various options and implementing any feasible options to maintain water in the main channel of the Virgin River. Exploring or implementing any such options will be in coordination with us, and other entities if appropriate, and will be conducted only if such options and associated activities are in compliance with applicable Federal laws and the laws of the State of Nevada, and within SNWA's authorities and resources approved by its governing Board.

Conservation Measures

Reclamation has included the following conservation measures for listed species in the action area as part of its proposed action. As described above, the AMP provides a process for assessing the effects of current operations of Glen Canyon Dam on downstream resources and using the results to develop recommendations for modifying dam operations and other resource management and conservation actions. The AMP also provides for long-term monitoring and research activities to evaluate the effectiveness of the operational modifications to Glen Canyon Dam and other management actions. All of the conservation measures listed below, with the exception of the humpback chub refuge and nonnative biocontrol symposium, have already been occurring through the AMP at various levels. For example, since 2003, the AMP has spent approximately $2.5 million on mechanical removal of nonnative fish species from the Colorado River in Grand Canyon as an experimental conservation measure to benefit humpback chub, approximately $200,000 on translocation of humpback chub, and since 1996, spent approximately $5 million on conducting two Beach Habitat Building Flow (BHBF) tests and several seasonal steady flow tests, all of which have likely benefited the species. We believe conservation measures carried out through the AMP have resulted in significant conservation benefits to humpback chub, Kanab ambersnail and southwestern willow flycatcher. The existence of the AMP and the history of conservation of these species through the AMP serve to substantiate that the following conservation measures will be implemented as proposed by Reclamation.

Humpback Chub

Nonnative Fish Control – In coordination with other DOI AMP participants and through the AMP, Reclamation will continue efforts to control both cold- and warm-water nonnative fish species in the mainstem of Marble and Grand canyons, including determining and implementing levels of nonnative fish control as necessary. Control of these species using mechanical removal and other methods will help to reduce this threat.

Humpback Chub Refuge – Reclamation will assist FWS in development and funding of a broodstock management plan and creation and maintenance of a humpback chub refuge population at a Federal hatchery or other appropriate facility by providing expedited advancement of $200,000 in funding to the FWS during CY 2008; this amount shall be funded from, and within, the amount identified in the MSCP BO (FWS 2005a; page 26). Creation of a humpback chub refuge will reduce or eliminate the potential for a catastrophic loss of the Grand Canyon population of humpback chub by providing a permanent source of genetically representative stock for repatriating the species.

Genetic Biocontrol Symposium – Reclamation will transfer up to $20,000 in fiscal year 2008 to FWS to help fund an international symposium on the use and development of genetic biocontrol of nonnative invasive aquatic species which is tentatively scheduled for October 2009. Although only in its infancy, genetic biocontrol of nonnative species is attracting worldwide attention as a potential method of controlling aquatic invasive species. Helping fund an effort to bring researchers together will further awareness of this potential method of control and help mobilize efforts for its research and development.

Sediment Research – In coordination with other DOI AMP participants and through the AMP, Reclamation will monitor the effect of sediment transport on humpback chub habitat and will work with the GCMRC to develop and implement a scientific monitoring plan acceptable to FWS. Although the effects of dam operation-related changes in sediment transport on humpback chub habitat are not well understood, humpback chub are known to utilize backwaters and other habitat features that require fine sediment for their formation and maintenance. Additional research will help clarify this relationship.

Parasite Monitoring – In coordination with other DOI AMP participants and through the AMP, Reclamation will continue to support research on the effects of Asian tapeworm (*Bothriocephalus acheilognathi*) on humpback chub and potential methods to control this parasite. Continuing research will help better understand the degree of this threat and the potential for management actions to minimize it.

Kanab Ambersnail

Monitoring and Research – Through the AMP, Reclamation will continue to monitor Kanab ambersnail and its habitat in Grand Canyon and the effect of dam releases on the species, and Reclamation will also continue to assist FWS in funding morphometric and genetic research to better determine the taxonomic status of the subspecies.

Southwestern Willow Flycatcher

Monitoring and Research – Through the AMP, Reclamation will continue to monitor southwestern willow flycatcher and its habitat and the effect of dam releases on the species throughout Grand Canyon and report findings to FWS, and will work with the National Park Service (NPS) and other AMP participants to identify actions to conserve the flycatcher.

Action Area

The geographic region that could be affected by the proposed action and interdependent actions (i.e., the action area) is shown in Figure 1 and includes the following areas:

- The Colorado River and its floodplain from the high-pool elevation of Lake Powell (elevation 3,700 msl) to the high-pool elevation of Lake Mead (elevation 1,229 msl).

- The channel of the Lower Virgin River and its floodplains and the channel of the Muddy River and its floodplains. The action area in the Lower Virgin River extends from the Nevada/Arizona border to the confluence of Lake Mead. The action area in the Muddy River begins south of the headwaters at Warm Springs and extends to the confluence of Lake Mead.

- The Colorado River and its floodplain from the high-pool elevation of Lake Mead to the southerly international boundary with Mexico.

As stated above, this biological opinion addresses the potential effects of the proposed action for all portions of the action area except from the high-pool elevation of Lake Mead (elevation 1,229 msl) to the southerly international boundary with Mexico. Because the proposed action could have indirect effects to fishes in the Lake Powell-to-Lake Mead reach of the action area, the action area also includes all streams tributary to the Colorado River in Glen Canyon National Recreation Area and Grand Canyon National Park, as well as the Little Colorado River (LCR) on Navajo Nation lands.

STATUS OF THE SPECIES AND CRITICAL HABITAT

Humpback chub

The humpback chub was listed as endangered on March 11, 1967 (32 FR 4001). Critical habitat for humpback chub was designated in 1994. Seven reaches of the Colorado River system were designated as critical habitat for humpback chub for a total river length of 379 miles in the Yampa, Green, Colorado, and Little Colorado rivers in Arizona, Colorado and Utah. Known constituent elements include water, physical habitat, and biological environment as required for each life stage (59 FR 13374; FWS 1994). Water includes a quantity of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, and turbidity) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage. Physical habitat includes areas of the Colorado River system for use in spawning, nursery, feeding, and rearing or corridors to these areas. The biological environment includes food supply and habitats with levels of nonnative predators and competitors that are low enough to allow for spawning, feeding, and rearing.

The humpback chub is a medium-sized freshwater fish (to about 20 inches) of the minnow family, Cyprinidae. The adults have a pronounced dorsal hump, a narrow flattened head, a fleshy snout with an inferior-subterminal mouth, and small eyes. It has silvery sides with a

brown or olive-colored back. The humpback chub is endemic to the Colorado River Basin and is part of a native fish fauna traced to the Miocene epoch in fossil records (Miller 1955, Minckley et al. 1986). Humpback chub remains have been dated to about 4000 B.C., but the fish was not described as a species until the 1940s (Miller 1946), presumably because of its restricted distribution in remote whitewater canyons (FWS 1990). Because of this, its original distribution is not known.

Populations of this species occur in the Little Colorado and Colorado rivers in the Grand Canyon, Black Rocks area of the Colorado River, Westwater Canyon, Cataract Canyon, Desolation/Grey Canyon, and Yampa Canyon (Valdez and Clemmer 1982, FWS 1990, 2002a). The largest population in the upper basin is in Westwater Canyon, with an estimated population size of about 2,400 adult fish (age 4+;≥ 200 mm total length); humpback chub are currently rare in the Yampa River and in Cataract Canyon (Finney et al. 2004, McAda 2004, Jackson 2004a, 2004b, and Utah Division of Wildlife Resources 2004). In Grand Canyon, adult population estimates based on the age-structured mark recapture (ASMR) model ranged from 10,000-11,000 in 1989 to 3,100-4,400 in 2001 (Coggins et al. 2006). However, between 2001 and 2006, numbers of adult fish, based on newer analyses using the ASMR model, appear to have increased from about 4,500-5,700 in 2001 to an estimated 5,300-6,700 in 2006 (USGS 2007).

Adult humpback chub may be found in deep, swift waters with varying depths. Backwaters, eddies, and runs have been reported as common capture locations for young-of-year humpback chub (Valdez and Clemmer 1982). These data indicate that in Black Rocks and Westwater Canyon, young utilize shallow areas. Habitat suitability index curves developed by Valdez et al. (1990) indicate young-of-year prefer average depths of 2.1 feet with a maximum of 5.1 feet. Average velocities were reported at 0.2 feet per second. Swimming abilities of young-of-year humpback chub were determined to be significantly reduced when laboratory water temperatures were reduced from 68 to 57.2° F (Berry and Pimentel 1985).

Little is known about the specific spawning requirements of the humpback chub. It is known that the fish spawn soon after the highest spring flows when water temperatures approach 68° F in the upper Colorado River basin (Kaeding et al. 1990, Karp and Tyus 1990, FWS 1990), and in the spring between March and May in the LCR when water temperatures are between 60.8° to 71.6°F. Habitats where ripe humpback chub have been collected are typically deep, swift, and turbid. As a result, spawning in the wild has not been directly observed. Gorman and Stone (1999) reported that ripe male humpback chub in the LCR aggregated in areas of complex habitat structure (i.e., matrix of large boulders and travertine masses combined with chutes, runs, and eddies, 1.6–6.6 feet deep) and were associated with deposits of clean gravel. Valdez and Ryel (1995, 1997) reported that during spring, adult humpback chub in the Colorado River in Grand Canyon primarily used large recirculating eddies, occupying areas of low velocity adjacent to high-velocity currents that deliver food items. They also reported that adults congregated at tributary mouths and flooded side canyons during high flows.

Robinson et al. (1998) and Stone and Gorman (2005) found that larval and juvenile humpback chub utilize nearshore habitats and quantified numbers of humpback chub that are transported by LCR flows into the mainstem. Robinson et al. (1998) and Stone and Gorman

(2005) also suggested that daily fluctuations in the mainstem river may reduce the quality of nearshore habitat for juvenile humpback chub, which may be particularly important during the monsoon period (July to November) when summer storms cause floods in the LCR, displacing large numbers of juvenile humpback chub into the mainstem (GCMRC unpubl. data). Pre-dam annual peak Colorado River flows (April–July) ponded canyon-bound tributary mouths (Howard and Dolan 1981), including the LCR. Robinson et al. (1998) theorized that because ponding probably retained drifting larvae or slowed their passage, it probably allowed greater time for development in a warm, low-velocity environment. Without this ponding effect, presumably more larval and juvenile humpback chub are likely transported into a now-harsher mainstem river while still at a size that is more vulnerable to thermal shock and predation.

Humpback chub are typically omnivores with a diet consisting of insects, crustaceans, plants, seeds, and occasionally small fish and reptiles. They appear to be opportunistic feeders, capable of switching diet according to available food sources, and ingesting food items from the water's surface, mid-water, and river bottom. Valdez and Ryel (1995) examined diets of humpback chub in Grand Canyon. Guts of 158 adults from the mainstem Colorado River, flushed with a nonlethal stomach pump, had 14 invertebrate taxa and nine terrestrial taxa, including simuliids (blackflies, in 77.8 percent of fish), chironomids (midges, 57.6 percent), *Gammarus* (freshwater shrimp, 50.6 percent), *Cladophora* (green alga, 23.4 percent), Hymenoptera (wasps, 20.9 percent), and cladocerans (water fleas, 19.6 percent). Seeds and human food remains were found in eight (5.1 percent) and seven (4.4 percent) fish respectively.

The decline of the humpback chub throughout its range is due primarily to habitat modification due to streamflow regulation and predation and competition by nonnative fish species (FWS 2002a). Streamflow regulation, in general, eliminates flow and temperature needs for spawning and successful recruitment, which is exacerbated by predation and competition from nonnative fishes. In Grand Canyon, brown trout (*Salmo trutta*), channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), and rainbow trout (*Oncorhychus* mykiss) have been identified as principal predators of juvenile humpback chub, with consumption estimates that suggest loss of complete year classes to predation (Marsh and Douglas 1997, Valdez and Ryel 1997). Valdez and Ryel (1997) also suggested that common carp (*Cyprinus carpio*) could be a significant predator of incubating humpback chub eggs in the LCR. In the upper basin, channel catfish have been identified as the principal predator of humpback chub in Desolation/Gray Canyons (Chart and Lentsch 2000), and in Yampa Canyon (FWS 2002a). Smallmouth bass (*Micropterus dolomieu*) have also become a significant predator in the Yampa River (T. Chart, FWS, pers. comm., 2007). Parasitism, hybridization with other native Gila, and pesticides and pollutants are also factors in the decline (FWS 2002a).

Many section 7 consultations have occurred on the humpback chub in both the upper and lower basins of the Colorado River. Activities that continue to adversely affect the humpback chub and its habitat throughout its range include dam operations, recreation, land uses that impact water quality, and the presence of nonnative species. However many surveys, and numerous projects to improve the species status, such as translocation and

nonnative species removal, have occurred for the species. Although the recovery goals for humpback chub that amend and supplement the 1990 Recovery Plan (FWS 2002a) are currently in revision, the document provides a complete discussion of the taxonomy, distribution, and life history of the species.

Kanab ambersnail

The Kanab ambersnail was listed as an endangered species without critical habitat in 1992 (57 FR 13657). The species is undergoing a 5-year review by the FWS, including a genetic evaluation of the species relatedness to other *Oxyloma*.

The genus *Oxyloma* has a broad distribution (North America, Europe and South Africa) with two species recognized in the southwestern United States: *O. retusa* in New Mexico and *O. haydeni* in Arizona and Utah. Within *O. haydeni* there are two subspecies, the Niobrara ambersnail (*O. h. haydeni*) and the Kanab ambersnail (*O. h. kanabensis*), both of which are found in Arizona and Utah. Populations of Kanab ambersnail presently occur from only four springs: two near Three Lakes, near Kanab, Utah, and two in Grand Canyon National Park, Arizona, one at a spring and hanging garden at RM 31.5 known as Vaseys Paradise, and a translocated population at Upper Elves Chasm, at RM 116.6 (Sorensen 2005). A third population in the Kanab area, near "the Greens," a seep-fed marsh, was believed to be lost due to dewatering in the last decade (FWS 1995a). The remaining populations near Three Lakes are located on private lands at several small spring-fed ponds on cattail (*Typha* sp.).

The population at Elves Chasm was created via translocation of snails from Vaseys Paradise. In 1998, the Arizona Game and Fish Department (AGFD) in coordination with the NPS, translocated snails to three sites in Grand Canyon National Park: Elves Chasm, Keyhole Spring, and Deer Creek. Although Elves Chasm was the only successful translocation, it has shown success including recruitment, overwinter survival, and increased density of snails (Sorensen and Nelson 2002). Recently Kanab ambersnail has become rare at Elves Chasm, although the species remains abundant at Vaseys Paradise (J. Sorensen, AGFD, pers comm., 2007).

The Kanab Ambersnail is dependent upon wetland vegetation for food and shelter, living in association with wetland plants including watercress (*Nasturtium*), monkeyflower (*Mimulus*), cattails, sedges (*Carex* spp.), and rushes (*Juncus* spp.). Stevens et al. (1997) found that Kanab ambersnail populations in the Grand Canyon region occur in areas where water sources originate from limestone or sandstone geologic strata. Kanab ambersnail at Vaseys Paradise predominantly use crimson monkeyflower and water-cress for food and shelter (Stevens et al. 1997a). The other Grand Canyon population, Upper Elves Chasm, is located above the 100,000 cfs stage of the river and is characterized by predominately crimson monkeyflower and maidenhair fern (*Adiantum capillus-veneris*), with lesser amounts of sedges, rushes, cattails, water-cress, helleborine orchids (*Epipactis gigantea*) and grasses (Poaceae)(Sorensen and Nelson 2002). From evidence collected in laboratory conditions, microclimatic conditions such as higher humidity and lower air temperatures relative to the surrounding environments and high vegetative cover may be important habitat features related to Kanab ambersnail survival (Sorenson and Nelson 2002).

Kanab ambersnails are hermaphroditic and capable of self-fertilization (Pilsbry 1948, Clarke 1991). Mature Kanab ambersnail mate and reproduce during the summer months (July and August), and deposit clear, gelatinous egg masses on undersides of moist to wet live stems, on the roots of water-cress, and on dead stems of crimson monkey-flower (Stevens et al. 1997a). In some years with relatively warm winters, more than one reproductive period can occur. Adult mortality increases in late summer and autumn leaving the overwintering population dominated by subadults. Young snails enter dormancy in October-November and typically become active again in March-April. Over-winter mortality of Kanab ambersnail can range between 25 and 80 percent (Stevens et al. 1997a & 1997b). Kanab ambersnail feed on plant tissue, bacteria, fungi and algae that are scraped off of dead plant tissue by means of a radula or rasp tongue. Stevens et al. (1997b) observed KAS feeding largely on crimson monkey-flower and water-cress.

Ongoing taxonomic studies indicate that although the population at Vaseys Paradise appears to be unique, the taxon itself may not be valid. Mitochondiral and cellular (microsatelite) DNA analysis indicates that the Kanab ambersnail may be part of a larger taxonomic group. However, these results are preliminary; the study is ongoing and should be completed in 2008 (M. Carver, University of Arizona, pers. comm. 2007).

Numerous biological opinions have been completed on the Kanab ambersnail. Most of these have been on the Grand Canyon population addressing the effects of experimental flows from Glen Canyon Dam. Activities that continue to adversely affect the Kanab ambersnail include water use, dam operations, and recreation-related trampling. However, many surveys, several research projects, and habitat salvage projects have occurred for the species. Stochastic events also continue to affect the distribution, quality, and extent of Kanab ambersnail habitat, predominantly drought.

Southwestern Willow Flycatcher

The southwestern willow flycatcher is a small grayish-green passerine bird (Family Tyrannidae) measuring approximately 5.75 inches. The song is a sneezy "fitz-bew" or a "fit-a-bew", the call is a repeated "whitt." It is one of four currently recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993). It is a neotropical migrant that breeds in the southwestern United States and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Stiles and Skutch 1989, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The historical breeding range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987).

The southwestern willow flycatcher was listed as endangered without critical habitat on February 27, 1995 (60 FR 10694; FWS 1995b). Critical habitat was later designated on July 22, 1997 (62 FR 39129; FWS 1997). On October 19, 2005, the FWS re-designated critical habitat for the southwestern willow flycatcher (70 FR 60886; FWS 2005b). A total of 737 river miles across southern California, Arizona, New Mexico, southern Nevada, and southern

Utah were included in the final designation. The lateral extent of critical habitat includes areas within the 100-year floodplain. The primary constituent elements of critical habitat are based on riparian plant species, structure and quality of habitat and insects for prey. A final recovery plan for the southwestern willow flycatcher was completed in 2002 (FWS 2002b).

Southwestern willow flycatchers primarily use Geyer willow (*Salix geyeriana*), coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), boxelder (*Acer negundo*), saltcedar (*Tamarix* sp.), Russian olive (*Elaeagnus angustifolia*), and live oak (*Quercus agrifolia*) for nesting. Other plant species less commonly used for nesting include: buttonbush (*Cephalanthus* sp.), black twinberry (*Lonicera involucrata*), cottonwood (*Populus* spp.), white alder (*Alnus rhombifolia*), blackberry (*Rubus ursinus*), and stinging nettle (*Urtica* spp.). Based on the diversity of plant species composition and complexity of habitat structure, four basic habitat types can be described for the southwestern willow flycatcher: monotypic willow, monotypic exotic, native broadleaf dominated, and mixed native/exotic (Sogge et al.1997).

Open water, cienegas, marshy seeps, or saturated soil are typically in the vicinity of flycatcher territories and nests; flycatchers sometimes nest in areas where nesting substrates were in standing water (Maynard 1995, Sferra et al. 1995, 1997). However, hydrological conditions at a particular site can vary remarkably in the arid Southwest within a season and among years. The flycatcher's habitat is dynamic and can change rapidly.

Throughout its range the southwestern willow flycatcher arrives on breeding grounds in late April and May (Sogge and Tibbitts 1992, Sogge et al. 1993, Sogge and Tibbitts 1994, Muiznieks et al. 1994, Maynard 1995, Sferra et al. 1995, 1997). Nesting begins in late May and early June and young fledge from late June through mid-August (Willard 1912, Ligon 1961, Brown 1988a, 1988b, Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993, Muiznieks et al. 1994, Whitfield 1994, Maynard 1995). Typically one brood is raised per year, but birds have been documented raising two broods during one season and renesting after a failure (Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993, Sogge and Tibbitts 1994, Muiznieks et al. 1994, Whitfield 1994, Whitfield and Strong 1995).

Unitt (1987) documented the loss of more than 70 southwestern willow flycatcher breeding locations rangewide (peripheral and core drainages within its range), estimating the rangewide population at 500 to 1000 pairs. Since 1993, a total of 133 sites once known to have breeding flycatchers are no longer presently occupied by nesting birds (Durst et al. 2006). There are currently 275 known southwestern willow flycatcher breeding sites in California, Nevada, Arizona, Utah, New Mexico, and Colorado (all sites from 1993 to 2005 where a resident flycatcher has been detected) holding an estimated 1,214 territories (Durst et al. 2006). While numbers have significantly increased in Arizona (145 to 495 territories from 1996 to 2005) (English et al. 2006), overall distribution of flycatchers throughout the state has not changed significantly. Currently, population stability in Arizona is believed to be largely dependent on the presence of two large populations (Roosevelt Lake and the San Pedro/Gila River confluence). Therefore, the result of catastrophic events or losses of significant populations either in size or location could greatly change the status and survival

of the bird. Conversely, expansion into new habitats or discovery of other populations would improve the known stability and status of the flycatcher.

The decline of the southwestern willow flycatcher has been attributed primarily to loss, modification, and fragmentation of riparian breeding habitat, along with a host of other factors including loss of wintering habitat and brood parasitism by the brown-headed cowbird (*Molothrus ater*) (Sogge et al. 1997, McCarthey et al. 1998). Habitat loss and degradation are caused by a variety of factors, including urban, recreational, and agricultural development, water diversion and groundwater pumping, channelization, dams, and livestock grazing. Fire is an increasing threat to willow flycatcher habitat (Paxton et al. 1996), especially in monotypic saltcedar vegetation (DeLoach 1991) and where water diversions and/or groundwater pumping desiccates riparian vegetation (Sogge et al. 1997). Willow flycatcher nests are parasitized by brown-headed cowbirds, which lay their eggs in the host's nest. Feeding sites for cowbirds are enhanced by the presence of livestock and range improvements such as waters and corrals, agriculture, urban areas, golf courses, bird feeders, and trash areas. When these feeding areas are in close proximity to flycatcher breeding habitat, especially coupled with habitat fragmentation, cowbird parasitism of flycatcher nests may increase (Hanna 1928, Mayfield 1977a, 1977b).

Since listing in 1995, approximately 150 Federal agency actions have undergone formal section 7 consultation throughout the flycatcher's range. Many activities continue to adversely affect the distribution and extent of all stages of flycatcher habitat throughout its range (development, urbanization, improper grazing, recreation, native and nonnative habitat removal, dam operations, river crossings, ground and surface water extraction, etc.); however, many surveys, riparian protection projects, and land acquisitions have occurred for the species. Stochastic events also continue to change the distribution, quality, and extent of flycatcher habitat.

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 which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Status of the species and critical habitat within the action area

Humpback Chub and its Critical Habitat

Humpback chub in the lower Colorado River basin (below Glen Canyon Dam) occurs in the Colorado River in Marble and Grand Canyons, and in the lower 10 miles of the LCR, constituting the Grand Canyon population, which also represents the lower basin recovery unit (FWS 2002a). Critical habitat in Arizona includes most of the habitat now used by the Grand Canyon population of humpback chub. Designated reaches are the lower 8 miles of

the LCR and from RM 34 (Nautiloid Canyon) to RM 208 (Granite Park) along the Colorado River. This represents approximately 28 percent of the historical habitat for the species, and 48 percent of critical habitat. The dominant factors affecting critical habitat in Grand Canyon are habitat alteration due to Glen Canyon Dam and the presence of nonnative fish that prey on and compete with native fishes. The known constituent elements are present and functional throughout designated critical habitat in the action area to some degree, primarily in the LCR; the mainstem Colorado River may provide all constituent elements, but at times appears too cold or has too many nonnative fishes to fully function.

The Grand Canyon population consists primarily of adults residing in and near the LCR, with much smaller aggregations of the species scattered throughout approximately 180 river miles of the Colorado River. Valdez and Ryel (1995) identified nine mainstem aggregations of humpback chub in Grand Canyon: 30 mile (RM 29.8 to 31.3); LCR Inflow (RM 57.0-65.4); Lava to Hance (RM 65.7-76.3); Bright Angel Creek Inflow (RM 83.8-93.2); Shinumo Creek Inflow (RM 108.1-108.6); Stephen Aisle (RM 114.9-120.1); Middle Granite Gorge (RM 126.1-129.0); Havasu Creek Inflow (RM 155.8-156.7); and Pumpkin Spring (RM 212.5-213.2). The contribution of mainstem aggregations, other than the LCR Inflow aggregation, to the overall Grand Canyon population are not known, but is thought to be small.

The relationship between fish in the LCR inflow area and the LCR itself is still uncertain; Douglas and Marsh (1996) suggested that two populations exist: one resident population in the LCR and one that migrates between the LCR and LCR inflow reach. However, Gorman and Stone (1999) suggested that the majority of adult humpback chub larger than 300 mm total length (TL) live in the LCR inflow reach except during the spawning migration. Movement between the LCR, the LCR inflow, and other mainstem aggregations has been documented, although most movement is between the LCR and the LCR inflow, with less movement between the other mainstem aggregations (Paukert et al. 1996).

The humpback chub was likely historically distributed throughout Grand Canyon, with local concentrations, although there is little information to gauge historical abundance. Valdez and Ryel (1995) estimate that the range of humpback chub in Grand Canyon has declined by about 61 miles or 24 percent since Glen Canyon Dam was completed, based on historical captures of humpback chub from the dam site to Separation Canyon (RM 241), and current capture locations from South Canyon (RM 30.0) to Granite Spring Canyon (221.0).

Coggins et al. (2006) summarized information on abundance and analyzed monitoring data collected since the late 1980s and found that data from all sources using various methods consistently indicated that the adult population had declined since monitoring began. Adult population estimates for an age-structured Jolly–Seber model ranged from about 14,500 in 1989 to about 2,400 in 2001; a similar model, the ASMR, estimated population size from 10,000-11,000 adults in 1989 to 3,100-4,400 in 2001 (Coggins et al. 2006). The main cause for the decline appears to be a decline in recruitment such that adult mortality exceeds recruitment. ASMR results suggest a peak in recruitment in the late 1970s to early 1980s of 13,500-18,500 age-2 fish. After that peak, an overall decline was evident to the early 1990s, when annual recruitment stabilized at about 2,000 age-2 fish (Coggins et al. 2006). Recent ASMR analyses indicate that the Grand Canyon population appears to have increased from

about 4,500-5,700 in 2001 to an estimated 5,300-6,700 in 2006 (USGS 2007); catch-rate indices also indicate dramatic increases in numbers of juvenile humpback chub (USGS unpublished data, FWS unpublished data).

The decline of humpback chub in Grand Canyon has long been thought to be due primarily to emplacement of Glen Canyon Dam. The predam river was a highly variable ecosystem. Flow varied greatly between seasons, from peak flood flows in May or June with a median monthly discharge of about 50,000 cubic feet per second (cfs), to low flows in January with a median monthly discharge of about 5,000 cfs. Flood flows of over 120,000 cfs were relatively common, occurring about every six years, and low flows of 500-1,000 cfs were also fairly common. Daily variation in discharge was relatively small, with a median of about 542 cfs (Topping et al. 2003). A very turbid and extremely sediment-laden stream much of the year, the river was nearly clear at low flows (Blinn and Cole 1990). Temperatures varied from 32° to 86° F (Korn and Vernieu 1998). Food base for fishes was likely meager due to the high turbidities usually present (Minckley 1991).

In contrast, the post-dam river is a more stable environment in all ways except for daily variation in discharge. The river now is limited by the 1996 ROD to discharges between 5,000 and 25,000 cfs, with the exception of beach habitat building flows which may be up to 45,000 cfs (U.S. Bureau of Reclamation 1996). Necessary to maximize the value of hydropower generation, releases from Glen Canyon Dam are typically lowest in the morning and peak in the early evening. The post-dam median daily change in discharge (8,580 cfs) is now approximately 15 times greater than pre-dam (542 cfs) and actually exceeds the pre-dam median discharge (7,980 cfs; Topping et al. 2003). Post-dam changes in discharge create dramatic changes in river stage, 6 feet or greater in some areas; pre-dam, diurnal stage change was seldom more than 1 foot (GCMRC unpublished data). The river is now perennially cold; hypolimnetic releases from Glen Canyon Dam are usually 50° to 53° F. Post-dam productivity is much higher in terms of algal and invertebrate biomass, thus food availability for fishes is likely greater than pre-dam (Blinn and Cole 1990). More than 95 percent of the sediment input is now trapped behind the dam, and the post-dam median discharge of 12,600 cfs causes remaining sediment to be lost continually (Topping et al. 2000, Topping et al. 2003).

Much of the Grand Canyon population of humpback chub, and the majority of all spawning, occurs in the lower 10 miles of the LCR. The LCR appears to be little changed hydrologically from pre-Anglo settlement times, and is similar in some respects to the pre-dam Colorado River. Flow ranges from a median low discharge of about 200 cfs in June to a median high discharge in April of about 600 cfs. When at low or base flow, this travertine system is relatively clear and turquoise blue. During floods, the LCR carries large sediment loads and is extremely turbid. Water temperatures range from near freezing to about 77° F. At low flow, the middle LCR at Cameron is dry, with flow in the lower river supplied entirely by Blue Springs, about 12.5 miles upstream from the confluence.

Many of the physical changes in the post-dam Colorado River are believed to have contributed to eliminating spawning and recruitment of humpback chub in the mainstem river. Humpback chub require a minimum of about 60° F for successful spawning, hatching

and rearing of young fish (Hamman 1982, Marsh 1985, Clarkson and Childs 2000, Muth et al. 2000). In addition, reductions in sediment supply have likely reduced the number and quality of nearshore habitats such as backwaters that young fish utilize as nursery habitats (Robinson et al. 1998, Hoffnagle 2000, Topping et al. 2003). Post-dam large scale fluctuations in daily discharge also result in stage changes that are thought to reduce the availability and quality of nearshore habitats (Robinson et al. 1998, Korman et al. 2004, Gloss et al. 2005, Stone and Gorman 2005). Fluctuations also increase the degree to which young humpback chub must move to find suitable habitats, increasing energy demands and vulnerability to predation (Korman et al. 2004). Cold temperatures can also cause larvae and juvenile fish to experience thermal shock (Berry 1988), and swimming ability is greatly reduced (Berry and Pimentel 1985, Ward and Bonar 2003). Juvenile humpback chub exiting the warm LCR and entering the cold mainstem thus may be too lethargic to effectively avoid predation or swim to suitable nearshore habitats (Valdez and Ryel 1995, Robinson et al. 1998).

Nonnative fish species have been present in the lower Colorado River, and likely in Grand Canyon, for over a century (Mueller and Marsh 2002). Since 1956, 24 nonnative fish species have been reported from Grand Canyon; 17 of which were present before the closure of Glen Canyon Dam (Valdez and Ryel 1995, Wieringa and Morton 1996). In Grand Canyon, brown trout, channel catfish, black bullhead, and rainbow trout have been identified as principal predators of juvenile humpback chub (Marsh and Douglas 1997, Valdez and Ryel 1997). Valdez and Ryel (1997) also suggested that common carp could be a significant predator of incubating humpback chub eggs in the LCR.

Generally, the upper reaches of the mainstem river are dominated by coldwater nonnative species, such as rainbow trout, and the lower reaches by warmwater species such as channel catfish and common carp. Brown trout are captured in greatest numbers in and near Bright Angel Creek (Rogers and Makinster 2006, Johnstone and Lauretta 2007). Catfish appear to be the dominant species in the mainstem below Diamond Creek and above the Lake Mead delta area (Ackerman 2007). Other nonnative species such as bullhead (*Ameiurus* spp.), fathead minnow (*Pimephales promelas*), red shiner (*Cyprinella lutrensis*), and plains killifish (*Fundulus zebrinus*) are primarily tributary species, mostly in the LCR (VanHaverbeke 2006) but can occur in the mainstem, especially downstream of the confluence of the LCR (Johnstone and Lauretta 2007). These small-bodied species may be important predators and competitors of young humpback chub.

The nonnative fish parasite Asian tapeworm may be a cause in the decline of humpback chub in Grand Canyon. The Asian tapeworm is a recent invader of the LCR; it was first reported from Grand Canyon in 1990 (Clarkson et al. 1997; Brouder and Hoffnagle 1997). It is considered a dangerous parasite capable of killing its hosts and may be a potential population-suppressing agent, although detrimental effects to humpback chub populations have not been documented (Meretsky et al. 2000, USGS 2004).

A number of actions have been undertaken under the auspices of the Glen Canyon Dam Adaptive Management Program to benefit the Grand Canyon population of humpback chub, all of which may explain the recent improvement in the status of the recovery unit, in terms

of numbers of adult and juvenile humpback chub in the LCR and mainstem river. In 1996 and 2004, beach habitat building flows were conducted; similar but smaller events were also conducted in 1997 and 2000. Juvenile humpback chub, thought to be from the 30-mile aggregation, where documented using backwaters downstream of 30-mile created by the 2004 event (R. VanHaverbeke, FWS, pers. comm., 2005). In 2000, a low summer steady flow was conducted; this flow markedly warmed the Colorado River, especially in nearshore areas, and appeared to benefit native fishes, although clear benefits to humpback chub were ambiguous (Trammel et al. 2002, USGS 2006). From 2003 through 2006, a 4-year program to remove nonnative fishes in a 10-mile reach near the LCR effectively reduced numbers of rainbow trout by more than 60 percent (GCMRC unpublished data). In 2002, 2003 and 2006 nonnative rainbow trout and brown trout were removed from Bright Angel Creek with backpack electrofishers and a fish weir (SWCA 2006, Sponholtz and VanHaverbeke 2007).

Reclamation requested formal consultation from FWS that included a conservation measure to translocate humpback chub upstream in the LCR as part of the 2002 consultation on implementation of nonnative fish control and experimental flows. The purpose of translocation was to improve survivorship of young humpback chub by reducing the potential for displacement of small young fish from the LCR into the mainstem, where cold temperatures and nonnative predators reduce their odds of survival. From 2003 to 2006, FWS translocated 1,150 juvenile humpback chub from the LCR near the confluence to areas of the LCR approximately 9 miles upstream above Chute Falls. Humpback chub were not previously known to occupy the LCR above Chute Falls, and the falls were assumed by many to be a barrier to humpback chub movement upstream. Monitoring revealed that translocated humpback chub exhibited remarkable growth rates and survival, successfully spawned, and that non-translocated humpback chub moved into the area, possibly due to the presence of translocated fish, disproving the hypothesis that Chute Falls is a barrier to humpback chub movement (Stone 2006, 2007).

For the period 2003 through 2006, low reservoir elevations in Lake Powell resulted in above average water temperatures of Glen Canyon Dam releases. In 2005, water temperatures in the mainstem Colorado River near the LCR exceeded 60.8°F, the warmest temperatures recorded since the reservoir filled in 1980, and adequately warm enough for humpback chub to successfully reproduce. This period of warming, along with the aforementioned conservation actions of the AMP, are thought responsible for the recent improvement in humpback chub status in Grand Canyon, although it is not known if any one action (i.e. nonnative removal or warm water) was most beneficial (USGS 2006).

Other actions in Grand Canyon that affect humpback chub include actions under the authority of the NPS under various management plans at Glen Canyon National Recreation Area and Grand Canyon National Park. These plans include activities such as commercial and noncommercial river trip permits, research permits, regulations on recreational use, and monitoring and management actions of the NPS. NPS recently completed its Colorado River Management Plan for management of recreation in Grand Canyon National Park, and completed consultation on the plan with FWS (FWS 2006). The plan includes implementing research on determining the possible effects of recreation on humpback chub; currently there is little available information on this subject.

The AGFD regulates recreational fishing for trout in Glen and Grand canyons. As previously discussed, nonnative trout are a predator and competitor of humpback chub. AGFD prohibits angling at the confluence area of the LCR and mainstem. Available information indicates that few rainbow trout in the Lees Ferry reach emigrate downstream (Maddux et al. 1987), although the lack of evidence of spawning and recruitment between Lees Ferry and the LCR suggests rainbow trout must emigrate from either upstream or downstream areas (GCMRC unpubl. data). AGFD also conducts a variety of monitoring activities, in conjunction with FWS and GCMRC, on humpback chub in Grand Canyon. Despite the essential need to monitor humpback chub status, netting and electrofishing can cause mortality (Ruppert and Muth 1997, Paukert et al. 2005).

Previous consultations on humpback chub in Grand Canyon have included the preferred alternative on the operations of Glen Canyon Dam, above powerplant-release experimental flows, nonnative trout removal, and various NPS management plans. Recent consultations are further summarized below.

Operation of Glen Canyon Dam

In January 1995, FWS concluded that the preferred alternative, the modified low fluctuating flow (MLFF) alternative, was likely to jeopardize the continued existence of the humpback chub and was likely to destroy or adversely modify their critical habitat. The 1995 biological opinion on the operation of Glen Canyon Dam identified a reasonable and prudent alternative (RPA) that was necessary to avoid jeopardizing the continued existence of the humpback chub. The biological opinion also anticipated take in the form of displacement of juvenile fish downstream during BHBF tests. BHBF releases are scheduled high releases of short duration that are in excess of power plant capacity in accordance with hydrologic triggering criteria, designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system.

Spring 1996 Beach Habitat Building Flow from Glen Canyon Dam

The first test of a BHBF was conducted in spring of 1996. BHBF tests were included as part of the proposed action of the FWS January 1995 biological opinion on the preferred alternative for the Operation of Glen Canyon Dam. Consultation with the FWS was re-initiated on the preferred alternative from the 1995 EIS because a new species was listed since the original consultation (the southwestern willow flycatcher with proposed critical habitat). The FWS concluded that the proposed test flow was not likely to jeopardize the continued existence of the humpback chub, and determined take from the proposed action in the form 25 humpback chub due to harm, harassment, and mortality due to displacement from the BHBF.

Fall 1997 Test Flow from Glen Canyon Dam

In November 1997 Reclamation conducted a fall test flow as a test of a powerplant release of 31,000 cfs for 48 hours. These smaller powerplant capacity flows, called Habitat

Maintenance Flows (HMFs), were designed to help maintain results achieved from BHBF events. Because such a test in the fall was not addressed in prior consultations, consultation was reinitiated. FWS concluded that the test flow was not likely to jeopardize the continued existence of the humpback chub and was not likely to destroy or adversely modify designated critical habitat for the humpback chub. Take of humpback chub was anticipated from harm, harassment and mortality from displacement of young humpback chub downstream.

2002 Proposed Experimental Releases from Glen Canyon Dam and Removal of Non-Native Fish

The FWS 2002 biological opinion covered the following actions: (1) experimental releases from Glen Canyon Dam (2) mechanical removal of nonnative fish from the Colorado River in an approximately 9-mile reach in the vicinity of the mouth of the Little Colorado River to potentially benefit native fish and; (3) release of nonnative fish suppression flows having daily fluctuations of 5,000-20,000 cfs from Glen Canyon Dam during the period January 1-March 31.

FWS concluded that the proposed action was not likely to jeopardize the continued existence of the humpback chub, nor adversely affect its critical habitat. The December 2002 biological opinion included the incidental take of up to 20 humpback chub during the nonnative fish removal efforts. The action included, as a conservation measure, translocation of 300 humpback chub above Chute Falls, to increase the survivorship of young humpback chub by providing habitats with reduced predation and improved conditions for growth via temperature and food base. This consultation was reinitiated twice in 2003, to modify the number and size of humpback chub that could be translocated, and to alter the geographic extent of nonnative fish removal.

2004 Fall BHBF Test

Consultation was conducted in 2004 to conduct a BHBF test in the fall because existing compliance only allowed for a full BHBF test in the spring. FWS concluded that the action was not likely to jeopardize the continued existence of the humpback chub nor adversely modify its critical habitat. Reclamation included several conservation measures for humpback chub including the continuation of humpback chub translocation in the Little Colorado River, and further study and monitoring of the results and study of effects on humpback chub from dam operations including BHBF tests and stable and fluctuating flows. No additional take of humpback chub was anticipated beyond that provided in the 2002 biological opinion.

Grand Canyon National Park Colorado River Management Plan

On January 3, 2006, FWS completed its biological opinion on the NPS Colorado River Management Plan, a visitor-use management plan which specifies actions to preserve park resources and the visitor experience while enhancing recreational opportunities. FWS concluded that the action was not likely to jeopardize the continued existence of the humpback chub nor adversely modify its critical habitat. Conservation measures for

humpback chub included restricting recreational use in the Little Colorado River, and implementing research to better determine the effect of recreational use on the species, as available funding permits. FWS anticipated incidental take in the form of harassment of humpback chub at the confluence of the Little Colorado River, from recreation-related disturbance, up to an amount that results in physical injury or morality; reasonable and prudent measures and terms and conditions included implementing research to determine the effect of recreation on humpback chub.

Kanab Ambersnail

In the action area, the Kanab ambersnail occurs in the vegetation at the spring-fed Vaseys Paradise. Vaseys Paradise is a popular water source and attraction site for Colorado River boat trips; however, access is limited by a dense cover of poison-ivy (*Toxicodendron rydbergii*). The habitat and population size of Kanab ambersnail is influenced by interseasonal and interannual conditions, including drought-induced variation in spring flow, die-back of vegetation, killing frosts, monsoon-related scour, browsing by ungulates (primarily bighorn sheep [*Ovis canadensis*]) and other factors. The population size may vary 10-fold between the end of the winter season and the peak of summer reproduction.

Historically, the Grand Canyon experienced annual floods of 100,000+ cfs and Kanab ambersnail were likely swept downstream and drowned (Stevens et al. 1997a). Today, Glen Canyon Dam limits such flood events, although several high flows above power plant capacity, such as beach habitat building flows, have resulted in discharges of up to 45,000 cfs. Flows of this magnitude will inundate and scour the occupied habitat of the Kanab ambersnail at Vaseys Paradise. Most, if not all, snails in the vegetation are washed down river or covered with sediment. Based on estimates calculated in August 2004, a flow of 45,000 cfs would scour approximately 1,285.2 square feet of habitat, approximately 17 percent of available habitat. During the 2004 beach habitat building flow, AGFD and GCMRC removed portions of ambersnail habitat in the potential inundation zone prior to the flood and later replaced these habitat pieces after flooding subsided. The conservation measure was deemed successful, as these lower habitat areas had recovered completely in 6 months. Recovery of this habitat from previous high flow tests that did not include habitat mitigation efforts required 3 years for ambersnail habitat to recover completely from scouring (Sorensen 2005).

Trampling by recreationists and flash floods from the talus slope above Vaseys Paradise also contribute to habitat loss and can results in direct KAS mortality. However, impacts from recreationists are likely minimal due to steep slopes and a dense cover of poison ivy. Additionally, plateau-origin flash floods are rare in the region (Stevens et al. 1997a).

Evidence exists that a small number of Kanab ambersnails at Vaseys Paradise were parasitized by a trematode, tentatively identified as *Leucochloridium* sp. (Stevens et al. 1997b). Potential vertebrate predators include rainbow trout (in submerged areas), summer breeding Say's and black phoebe (*Savornis savi* and *S. niaricans*), canyon wren (*Catherpes mexicanus*), winter resident American dipper (*Cinclus mexicanus*), and canyon mice (*Peromyscus crinitus*) (Stevens et al. 1997b, FWS 1995a). Predation rates by birds and mice

are not available, but analysis of mice feces indicates that snails are not regularly eaten by rodents (Meretsky and Wegner 1999).

Water sedge, a plant with patchy distribution in Kanab ambersnail habitat, is a source of forage for bighorn sheep, especially during a drought. Vaseys Paradise is now regularly used by bighorn sheep, resulting in vegetation used by the snails being trampled (Gloss et al. 2005). Drought conditions from 2001-2003 caused one of the two prominent spring caves to go completely dry in 2004. The drought conditions and increased grazing by bighorn sheep in the snail's habitat at Vaseys Paradise caused a shift in vegetation resulting in more mixed plots with less watercress and apparently reduced the amount and quality of ambersnail habitat; as a result, numbers of ambersnails declined. Wetter conditions since then have resulted in both spring caves flowing again; habitat appears to have improved, although numbers of ambersnails detected in plot sampling are still relatively low (Sorensen 2005).

Reproduction has been documented in the population introduced at Elves Chasm, and the population is self-sustaining, although recently the ambersnail has become rare at this location. In 1999, an expert panel was convened to evaluate the status of this species and related mollusk species. Questions about species management and genetic identification remain. An "Interim Conservation Plan of Oxyloma (haydeni) kanabensis complex and Related Ambersnails in Arizona and Utah" has been developed by AGFD (Sorensen and Nelson 2002) and guides current management.

Previous consultations for this species in Grand Canyon have included the preferred alternative on the operations of Glen Canyon Dam, above powerplant release experimental flows, and other actions; these consultations are summarized below.

Operation of Glen Canyon Dam

In January 1995, FWS concluded that the preferred alternative on operations of Glen Canyon Dam, the MLFF alternative was not likely to jeopardize the continued existence of the Kanab ambersnail. Take of Kanab ambersnail was anticipated in the form of harm, harassment and mortality from the scouring loss of habitat during BHBF tests in the amount of 10 percent of occupied habitat at Vaseys Paradise.

Spring 1996 Beach Habitat Building Flow from Glen Canyon Dam

Consultation was reinitiated on the proposed action of the January 1995 biological opinion to allow for a proposed test of a BHBF from Glen Canyon Dam in the spring of 1996, because a new species had been listed (southwestern willow flycatcher), and in part because new information revealed that incidental take for the Kanab ambersnail would be exceeded. FWS concluded that the action was not likely to jeopardize Kanab ambersnail, and anticipated take in the form of harm, harassment, and mortality from the scouring loss of habitat during the BHBF in the amount of 17 percent of the Kanab ambersnail habitat at Vaseys Paradise. Reasonable and prudent measures and terms and conditions included monitoring of effects of the test on the Vaseys Paradise population, and translocating snails out of the inundated zone into higher elevation habitat.

Fall 1997 Test Flow from Glen Canyon Dam

In November 1997, Reclamation conducted a fall test flow as a test of a powerplant release of 31,000 cfs for 48 hours, an HMF. Because such a test in the fall was not addressed in prior consultations, consultation was reinitiated. FWS concluded that the action was not likely to jeopardize Kanab ambersnail, and anticipated take in the form of harm and mortality from the scouring loss of habitat during the BHBF in the amount of 1 percent of the Kanab ambersnail habitat at Vaseys Paradise. Reasonable and prudent measures and terms and conditions included monitoring of effects of the flow on the Vaseys Paradise population, and establishing a refuge population and a second wild population.

2002 Proposed Experimental Releases from Glen Canyon Dam and Removal of Non-Native Fish

The December 2002 biological opinion included the following actions: (1) experimental releases from Glen Canyon Dam (2) mechanical removal of nonnative fish from the Colorado River in an approximately 9-mile reach in the vicinity of the mouth of the Little Colorado River to potentially benefit native fish and; (3) release of nonnative fish suppression flows having daily fluctuations of 5,000-20,000 cfs from Glen Canyon Dam during the period January 1-March 31.

FWS concluded that the action was not likely to jeopardize Kanab ambersnail. The proposed action included a conservation measure consisting of temporary removal and safeguard of approximately 25 to 40 percent of Kanab ambersnail habitat that would be flooded by the experimental release. The relocated habitat would be replaced once the high flow was complete to facilitate re-establishment of vegetation. Take was anticipated in the form of harm and mortality from the scouring loss of 1,259.4 square feet of habitat during a BHBF.

2004 Fall BHBF Test

Consultation was re-initiated in 2004 to conduct a BHBF test in the Fall because existing compliance only allowed for a test in the spring. FWS concluded that the action was not likely to jeopardize the continued existence of the Kanab ambersnail. The proposed action included a conservation measure consisting of temporary removal and safeguard of approximately 25 to 40 percent of Kanab ambersnail habitat that would be flooded by the experimental release. The relocated habitat would be replaced once the high flow was complete to facilitate re-establishment of vegetation. Take was anticipated in the form of harm and mortality from the scouring loss of 1,285.2 square feet of habitat during a BHBF.

Grand Canyon National Park Colorado River Management Plan

On January 3, 2006, FWS completed its biological opinion on the NPS Colorado River Management Plan, a visitor-use management plan which specifies actions to preserve park resources and the visitor experience while enhancing recreational opportunities. FWS concluded that the action was not likely to jeopardize the continued existence of the Kanab

ambersnail. Conservation measures included educating river guides about the presence of the species and potential for recreation-induced impacts, monitoring, and, as available funding permits, implementing research to assess the effects of recreation on Kanab ambersnails. Take was anticipated in the form of harm and mortality in the amount of 107.6 square feet of Kanab ambersnail habitat at Vaseys Paradise from recreational use.

Southwestern Willow Flycatcher and its Critical Habitat

Lake Powell to Lake Mead Reach of the Colorado River

Flycatcher territories in the Grand Canyon are generally located in the tamarisk-dominated riparian vegetation along the river corridor but not in the mesquite-acacia and hackberry-dominated habitats higher on the slopes (James 2005). The flycatcher's nesting habitat is dynamic in that it varies in occupancy, suitability, and location over time. Because river channels, river flows, and floodplains are varied and can change, the location and quality of nesting habitat may also change over time.

Southwestern willow flycatchers have consistently nested along the Colorado River in the Grand Canyon over the last 30 years, although suitable habitat is extremely disjunct through the river corridor from approximately RM 28 to RM 274 (Gloss et al. 2005, James 2005, Christensen 2007). Surveys conducted between 1992 and 2007 indicate a very small resident breeding population in upper Grand Canyon, mostly at RM 50-51 and the area around RM 28-29, although only 1 to 5 territories have been detected in any one year. Another area of importance in the mid-1990s was RM 71-71.5. However, that area does not appear to have been occupied for the last 10 years (Gloss et al. 2005, James 2005).

Beginning in 1998, flycatchers were frequently detected along the Colorado River in lower Grand Canyon downstream of Separation Canyon. This area is strongly influenced by water levels in Lake Mead. Potential southwestern willow flycatcher habitat in the area has changed dramatically in the last 5 years as the result of a 89-foot drop in the level of Lake Mead since 2000. Areas that were inundated in the late 1990s are now well above the current water level, and the existing riparian vegetation in many of these areas is dead or dying (James 2005, Christensen 2007). This Lower Gorge area of Grand Canyon (RM 246-272) supported as many as 12 territories in 2001; however, with drought, and lower Lake Mead elevations, this area has since supported only a single successful nesting pair, in 2004. New flycatcher habitat is developing at the lower drought-induced reservoir levels, and occupation of this area is expected to increase in the near future. The Lower Gorge is downstream of the MSCP planning area boundary at approximately RM 235. All elements of the proposed action affecting the Colorado River below RM 235 (and the flycatchers in the Lower Gorge) were covered in the MSCP BCO (FWS 2005a).

Suitability of riparian habitat for nesting flycatchers can be extremely ephemeral or dynamic; an area that can support nesting birds in one year may not in subsequent years, only to begin supporting the flycatcher again. The ephemeral nature of flycatcher nesting habitat is largely due to the presence of water, which varies due to climate and hydrologic conditions (FWS 2002b). Flycatcher nesting habitat in upper Grand Canyon is less affected by drought or

flooding because of the relatively constant hydrology, and because species composition is largely drought-resistant tamarisk. Changes in river flow due to dam operations can affect the quality or suitability of nesting flycatcher habitat (e.g. numbers of flying insects), but generally not its presence or absence (i.e. some nesting habitat, in the form of suitable riparian vegetation, is always present). The presence and persistence of nesting flycatchers in upper Grand Canyon is also likely related to occupation of nearby areas in the Lower Gorge downstream. Although drought has recently caused these downstream areas to be occupied in lower numbers, flycatchers still nest in the action area. Also, new habitat is establishing at the drought-induced lower reservoir elevations of Lake Mead (Christensen 2007). Thus, we find that the action area is currently occupied by nesting flycatchers, and is expected to remain occupied for the duration of the proposed action.

Actions that affect the flycatcher in Grand Canyon include operations of Glen Canyon Dam that can dry out or inundate habitat, or possibly remove it during floods, and disturbance from recreational river rafting. In 2004, Grand Canyon National Park implemented an emergency closure to protect nesting flycatchers at two sites. The closure was in effect from May 1 to July 15 and included closure to visitor use including hiking, camping, and river landings at RM 28.1-28.5 (river left) and RM 50.2-50.6 (river left). A closure at Cardenas (RM 70) was instituted in the early and mid-1990s.

Previous consultations on southwestern willow flycatcher in Grand Canyon have included the preferred alternative on the operations of Glen Canyon Dam, above powerplant release experimental flows, and various NPS management plans including the recently completed CRMP. Some adverse effects were anticipated, although many were minimized. Notable consultations are further described below.

Spring 1996 Beach Habitat Building Flow from Glen Canyon Dam

Consultation was reinitiated to allow for a proposed test of a beach habitat building flow from Glen Canyon Dam in the spring of 1996. FWS concluded that the action was not likely to jeopardize the flycatcher nor result in the adverse modification of proposed critical habitat. Take was anticipated in the form of harm in the amount of inundation of nest trees up to a depth of 4.9 feet.

Grand Canyon National Park Colorado River Management Plan

On January 3, 2006, FWS completed its biological opinion on the NPS Colorado River Management Plan, a visitor-use management plan which specifies actions to preserve park resources and the visitor experience while enhancing recreational opportunities. FWS concluded that the action was not likely to jeopardize the continued existence of the flycatcher. Conservation measures included conducting presence/absence surveys at least every other year, and conducting annual surveys including nest monitoring as funding is available. No take was anticipated.

Virgin and Muddy Rivers

Southwestern willow flycatcher studies have been conducted along the Virgin and Lower

Colorado rivers and tributaries annually since 1997, in compliance with requirements set forth by the FWS for Reclamation's routine operations and maintenance along the Lower Colorado River. Portions of the Lower Colorado Recovery Unit and Virgin Management Unit occur within the SNWA proposed project area. Vegetation in the proposed project area along the Virgin River is a diverse mix of native and nonnative riparian trees and shrubs with large monocultures of tamarisk in various age classes on the higher, more arid terraces of the floodplain. Native vegetation is composed primarily of coyote willow, Goodding's willow, Fremont cottonwood, arrowweed (*Pluchea sericea*), seepwillow (*Baccharis* spp.) and cattail, and occurs in small patches on bare sand, on gravel deposits, and adjacent to agricultural fields (supported by irrigation runoff) or in mixed association with tamarisk (Brown 2004).

From 2003 to 2007, the number of adult southwestern willow flycatchers detected at several sites along the Virgin River near the City of Mesquite and Town of Bunkerville, Nevada, ranged from a low of 19 to a high of 38. At these sites, which total about 50 acres, the number of nests ranged from a low of 13 to a high of 21, with nesting success rates typically at less than 50 percent (SWCA 2007). Further downstream near Halfway Wash at the Mormon Mesa survey sites, which total about 341 acres, a range of 14 to 30 adult flycatchers has been documented from 2003 to 2007. The number of nests at the Mormon Mesa sites has varied from 6 to 13 from 2003 to 2007, with nesting success ranging from 0 to 45 percent (SWCA 2007). The Mesquite and Mormon Mesa sites are all within the SNWA proposed project area. In 2004, the Bureau of Land Management initiated surveys for the species for a tamarisk removal and riparian restoration project along the Virgin River near the City of Mesquite and Town of Bunkerville, Nevada. Six additional southwestern willow flycatcher territories and nine resident birds were documented in willow- or native-dominated habitat in abandoned meander channels in low-lying portions of the floodplain (Brown 2004). Additionally, 20 migrant birds were detected during May and June with half of the detections associated with willow-dominated, abandoned meander channels (Brown 2004). All of these detections are within the SNWA proposed project area.

Within the SNWA proposed project area, southwestern willow flycatchers have also been documented as breeding at the Overton Wildlife Management Area (WMA) and the Warm Springs Natural Area (formerly known as the Warm Springs Ranch) in riparian vegetation along the Muddy River upstream of the town of Moapa, Nevada. The habitat along the Muddy River consists of a mix of native and nonnative vegetation, including coyote willow, western honey mesquite (*Prosopis glandulosa* var. *torreyana*), and tamarisk, as well as ash (*Fraxinus velutina*), Fremont cottonwood, and California fan palm (*Washingtonia filifera*). An estimated 490-foot wide strip of riparian vegetation, or about 37 acres on both sides of the Muddy River, supports the southwestern willow flycatcher at the Overton WMA (FWS 2005, SWCA 2005). From 2005 to 2007 the number of adult southwestern willow flycatchers detected at Overton WMA ranged from 12 to 16. The number of nests at this site from 2005 to 2007 ranged from 8 to 12, with a less than 50 percent nesting success rate in most years. Surveys at the Warm Springs Natural Area from 2003 to 2005 recorded 1 or 2 nesting pairs, with zero or unknown nesting success; however, no southwestern willow flycatchers were detected at the site in 2000, 2001 and 2006 and only migrants were observed in 2002 (Nevada Department of Wildlife 2007).

Critical habitat for the southwestern willow flycatcher for the Virgin River segment is designated as a contiguous segment of the Virgin River in Utah, Arizona, and Nevada (FWS 2005b). The segment extends for 73.8 miles from the Washington Field Diversion Impoundment in Washington County, Utah, downstream through the Town of Littlefield, Arizona, and ends in Nevada at the upstream boundary of the Overton WMA in Clark County, Nevada. This segment exists for 18.6 miles along the Virgin River in Nevada and is located in the Virgin Management Unit of the Lower Colorado Recovery Unit. The Virgin River segment, like the other river segments of the critical habitat, is essential for conservation because it contains one or more of the primary constituent elements, and as a result, provides southwestern willow flycatcher habitat for breeding, feeding, sheltering, and migration that subsequently provides metapopulation stability, gene flow of the subspecies, and connectivity between neighboring Management Units and Recovery Units (FWS 2002b, 2005b). The Virgin River segment, along with the other river segments of critical habitat, contributes habitat in order to help provide for the numerical and habitat-related goals identified in the Recovery Plan. All critical habitat in the Virgin River Management Unit in Nevada, and a small portion in Arizona to the Mesquite Diversion, lies within the SNWA proposed project area. Critical habitat was not designated for southwestern willow flycatcher along the Muddy River. Specifically, State Wildlife Areas excluded under section 4(b)(2) of the Act included the Overton WMA (FWS 2005b).

EFFECTS OF THE ACTION

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

Bureau of Reclamation Analysis Methodology and Assumptions

Our analysis of the effects of the proposed action relies in part on Reclamation's analysis from their EIS and biological assessment (U.S. Bureau of Reclamation 2007a, 2007b, 2007c). This section describes the methods and assumptions used by Reclamation to conduct the analysis of potential effects of the proposed action on species in the Lake Powell to Lake Mead portion of the action area. Potential effects of the proposed action on listed species could result from changes in Lake Powell reservoir storage and release operations from current conditions. The potential hydrologic effects could result in changes in the range and duration of the water elevations maintained in Lake Powell, and river flow, river temperature, and sediment transport in the Colorado River, that support habitat conditions for the listed species. Reclamation compared Lake Powell elevations; river flows; average monthly river temperatures at Lees Ferry, the LCR confluence and below Diamond Creek; and river sediment transport under current conditions, to conditions expected under the proposed action to evaluate if differences in hydrologic conditions under the proposed action would affect listed species and designated critical habitats.

Future Colorado River system conditions under the current and the proposed action conditions were simulated using the Colorado River Simulation System (CRSS). The model framework used for this process is a commercial river modeling software called RiverWare™. RiverWare™ is a generalized river basin modeling software package developed by the University of Colorado through a cooperative process with Reclamation and the Tennessee Valley Authority. CRSS was originally developed by Reclamation in the early 1970s and was first utilized with RiverWare™ in 1996. River operation parameters modeled and analyzed in CRSS include the water entering the river system, storage in system reservoirs, releases from storage, river flows, and the water demands of and deliveries to water users in the Basin States and Mexico.

The future water supply used as input to the model consisted of data sampled from the historical record of natural flow in the river system over the 100-year period from 1906 through 2005, including 29 individual inflow points (or nodes) on the system. The future Colorado River water demands were based on demand and depletion projections prepared by the Basin States. Depletions are defined as diversions from the river less return flow credits, where applicable. The operation of the mainstream reservoirs including Lake Powell and Lake Mead is provided as a set of operating rules that describe how water is released and delivered under various hydrologic conditions. Additional information on the hydrologic modeling methodology is available in Section 4.2 of the EIS (U.S. Bureau of Reclamation 2007a). CRSS model outputs included the relative probability of different size annual releases and minimum, average and maximum daily releases associated with various levels of annual release. The 10th, 50th and 90th percentile monthly releases from Glen Canyon Dam were also evaluated as a relative indicator of flow conditions between Glen Canyon Dam and Lake Mead. The 10th, 50th, and 90th percentile Lake Powell elevations were used to evaluate potential changes to Lake Powell conditions.

Lake Powell undergoes seasonal transformations that can dramatically affect the temperatures of both the reservoir and dam releases. During the spring, solar radiation and warmer air temperatures begin to warm the upper surface layers of the reservoirs. This warming is also affected by spring inflow volumes and temperatures. Larger inflows bring greater volumes of warmer water that can cause higher release temperatures. Lower reservoir elevations bring the warmer surface water closer to the power plant intake penstocks, also producing warmer releases. As summer progresses, surface warming of reservoirs increases, as does the warming of releases as the water moves downstream. During the winter months, reservoir temperature stratification is usually eliminated by reservoir mixing, and both reservoir and downstream water cooling occurs. Reclamation's CE-QUAL-W2 model was used to simulate this annual process and to analyze dam release temperatures for various reservoir starting elevations and inflows. The CE-QUAL-W2 model was used to establish the relationship between reservoir elevation and dam release temperatures. Calibration of the CE-QUAL-W2 model for Lake Powell used historical temperature profiles from 1990 to 2005 at 13 reservoir stations. Coupled with that relationship, the CRSS output of dam release and reservoir elevations was used to project dam release temperatures.

The Generalized Environmental Modeling System for Surface Waters (GEMSS) model was used to route Glen Canyon Dam release temperatures through the Grand Canyon downstream to Lake Mead. The GEMSS model was calibrated for water temperature at three locations in this river reach: Lees Ferry, 15.9 miles downstream of Glen Canyon Dam; a point 1 mile downstream of the LCR confluence; and the Diamond Creek gauging station 240 miles downstream of Glen Canyon Dam. Below Diamond Creek, water temperatures approached equilibrium with the ambient air temperature, and the rate of temperature change decreased.

For any specific reservoir starting elevation, there is a range of potential dam release temperatures because the reservoir is affected by the magnitude of spring inflow and summer meteorological conditions. Downstream water temperatures produced by a routing of these releases are also affected by meteorological conditions and the magnitude of dam releases. Thus, for a single reservoir elevation the CE-QUAL-W2 and GEMSS modeling resulted in a range of water temperatures. Reclamation utilized a range of potential water temperatures that included a minimum and maximum monthly temperature at three river locations for the 10th, 50th, and 90th percentile Lake Powell elevation release condition, as well as an average of the potential range. Average river temperature by month at Lees Ferry, the LCR confluence, and Diamond Creek confluence were evaluated to identify whether the proposed action would affect river temperature compared to current conditions. Temperature model results were used to evaluate potential effects to various life stages of listed fish.

To estimate the effects of modifying the annual release volumes from Glen Canyon Dam under the proposed action on sediment transport, the USGS prepared an analysis relating normalized sediment transport from the Grand Canyon to annual release volumes. Table 4 shows this relationship, with 8.23 maf release volumes as the basis for normalization. The probabilities of different levels of annual release were used to qualitatively evaluate potential differences in sediment transport and instream conditions for listed fish.

The hydrologic model, CRSS, used as the primary basis of Reclamation's effects analysis does not project future inflows, but rather relies on the historic record to analyze a range of possible future inflows. Projections of future reservoir elevations are probabilistic, based on the 100-year historical record to project future inflows. The historical record includes periods of extreme drought and periods with above average flow, allowing analysis of the proposed Federal action under a wide range of future flow conditions. However, it is possible that future flows may include periods of wet or dry conditions that are outside the range of sequences observed in the historical record, particularly as a result of climate change and increased climate variability.

The Fourth Assessment Report (Summary for Policymakers) of the Intergovernmental Panel on Climate Change (IPCC), published in April of 2007 (IPCC 2007), presented a selection of key findings regarding projected changes in precipitation and other climate variables as a result of a range of unmitigated climate changes projected by IPCC over the next century. Although annual average river runoff and water availability are projected to decrease by 10-30 percent over some dry regions at mid-latitudes, information with regard to potential impacts on specific river basins was not included. Recently published projections of potential reductions in natural flow on the Colorado River Basin by the mid 21st century

range from approximately 45 percent by Hoerling and Eischeid (2006), to approximately 6 percent by Christensen and Lettenmaier (2006). A recent analysis of future precipitation minus evaporation (a surrogate for runoff) in the basin suggests an "imminent transition to a more arid climate in southwestern North America" (Seager et al. 2006). While these projections are of great interest, additional research is both needed and warranted to quantify the uncertainty of these estimates (in terms of the actual uncertainty in the climate response as well as the uncertainty due to differences in methodological approaches and model biases) in order to better understand the risks of current and future water resource management decisions.

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, Reclamation based its hydrologic analysis for its EIS and biological assessment primarily on the re-sampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of the historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies. The methodologies, including stochastic hydrology methods and paleo-reconstruction methods and the results, were analyzed in Appendix N of the Draft EIS. An additional analysis was added in the Final EIS that incorporates a newly published tree-ring reconstruction (Meko et al. 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1,244 years.

Although precise estimates of the future impacts of climate change to runoff throughout the Colorado River Basin at appropriate spatial scales are not currently available, these impacts may include decreased mean annual flow and increased variability, including more frequent and more severe droughts. Even without precise knowledge of the effects on runoff, increasing temperatures alone would likely increase losses (e.g., evapotranspiration and sublimation), resulting in reduced runoff.

Acknowledging the potential for impacts due to climate change and increased hydrologic variability, the Guidelines are proposed to be interim in duration and extend through 2026, providing the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead, particularly for low reservoir conditions, and improve the basis for making additional future operational decisions, whether during the interim period or thereafter. In addition, the proposed action has been crafted to include operational elements that would respond if potential impacts of climate change and increased hydrologic variability are realized. In particular, the proposed action includes a coordinated operation element that allows for the adjustment of Lake Powell's release to respond to low reservoir storage conditions in Lake Powell or Lake Mead as described in Section 2.7 and Section 2.3 in the Final EIS (U.S. Bureau of Reclamation 2007b). In addition, the Proposed Action will enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead through adoption of the ICS mechanism. Finally, the Proposed Action includes a

shortage strategy at Lake Mead that would result in additional shortages being considered, after appropriate consultation, if Lake Mead elevations drop below 1,025 feet msl.

Humpback Chub and its Critical Habitat

Changes in allowable annual release volume under the proposed action will essentially create a more variable and potentially drier Colorado River in Grand Canyon annually. Whereas release volume in low runoff years has been restricted to 8.23 mafy under current conditions, the Guidelines will allow more flexibility, generally allowing from 7.0 to 9.0 mafy. Thus, the proposed action could alter critical habitat including the Primary Constituent Elements (PCEs) related to sediment transport, water temperature, and flow volumes in the Colorado River below Glen Canyon Dam relative to current conditions. These changes could result in adverse effects to humpback chub in three primary ways: 1) increased competition and predation from nonnative fish species; 2) increased parasitism from Asian tapeworm and anchorworm (*Lernaea cyprinacea*); and 3) a reduction in the suitability of mainstem nearshore habitats due to changes in river flow and sediment transport.

Sediment transport is directly related to river flow. The relationship of sediment transport to annual flow volume in Grand Canyon is shown in Table 4. The proposed action could result in annual releases from Glen Canyon Dam of less than 8.23 mafy, approximately 13 percent more frequently than under current conditions, which would reduce the transport of sediment out of the river and into Lake Mead. Reclamation predicts that annual release rates above the minimum objective release of 8.23 maf (8.23 mayf to 9.00 mafy) could occur at a frequency about 13.5 percent greater than under current conditions. These higher releases would transport more sediment out of the river. Although the probability of releases above 9 mafy (9.01 mafy to above 16 mafy) is anticipated to be only slightly different under the proposed action (about 0.84 percent higher), because the proposed action is expected to be greater than 8.23 mafy more often than it will be less than 8.23 mafy (1.34 percent greater overall), the overall effect of the proposed action will be to increase net transport of sediment out of the system.

The quantitative effects of these changes in release rates on instream habitat suitability for humpback chub are difficult to predict. Backwaters are formed from fine-grained sediment within circulation zones; when river stage decreases, eddies often become backwaters (Weiss 1992). Backwaters are dynamically related to discharge and available sediment (Dawdy 1991). Goeking et al. (2003) noted considerable temporal variability in both backwater number and area with river discharge, and also variability among sites within a given year. They also found that backwater area tends to decline in the absence of floods (releases at or above powerplant capacity) and increase following floods, however the relationship between backwater area, depth and water temperature has not been established, making predictions for effects to humpback chub difficult. On the other hand, Stevens and Hoffnagle (1999) found that both backwater number and area decrease at flows above 10,000 cfs, and similar findings were documented by McGuinn-Robbins (1997) and Weiss (1992). Goeking et al. (2003) also implied that variability in backwater formation and persistence is more affected by diel fluctuations than monthly volume. These relationships, together with more frequent releases above 8.23 maf under the proposed action may act to reduce backwater availability in the

mainstem during certain years. This reduction in backwater availability could adversely affect humpback chub, especially during the months of August and September when those habitats are most critical, because monsoon flood events in the LCR displace small humpback chub into the mainstem (GCMRC unpubl. data). Because backwaters may be important nursery habitats for juvenile humpback chub (AGFD 1996, Robinson et al. 1998, Stone and Gorman 2006), a reduction in the number of available backwaters is expected to increase mortality of young humpback chub, and negatively affect this primary constituent element of critical habitat.

Changes in annual releases from Glen Canyon Dam under the proposed action could also result in increases or reductions in the potential range of hourly maximum and minimum releases from Glen Canyon Dam. At the minimum objective release of 8.23 mafy, the daily range of flows from Glen Canyon Dam under current conditions is approximately 6,000 to 8,000 cfs with the wider range in July, August, December, and January. The potential hourly range at annual release rates of 7.48 mafy could be reduced by as much as 1,000 to 2,000 cfs/day in April and October through December. Release rates between 9.0 mafy and over 16 mafy are about 0.84 percent more likely, and there is a 13.5 percent greater likelihood under the proposed action for equalization under volumes between 8.23 mafy and 9.0 mafy (these will typically be 9.0 mafy releases). These releases will result in higher flows during the months of June through September. Because there appears to an inverse relationship between backwater availability and flow volume (Weiss 1992, McGuinn-Robbins 1997, Stevens and Hoffnagle 1999) impacts to backwater habitat availability could be significant. Humpback chub young-of-year are typically abundant in the mainchannel during those months, so there could be an adverse affect in the form of a reduction in backwater availability, and potentially an increase in mortality of juvenile humpback chub. However, available information on the availability of backwaters in relation to flow and the overall importance to the Grand Canyon population of humpback chub is poorly understood, so predicting the overall consequence of this effect is not possible at this time (Melis et al. 2007).

Changes in allowable annual release volume under the proposed action will create more variability in the water temperatures of the Colorado River in Grand Canyon. In the Colorado River at Lees Ferry, modeling results indicate that monthly average water temperatures would be essentially the same under the 10th, 50th, and 90th percentile conditions in all months but below the requirements for humpback chub spawning and egg incubation.

At the confluence of the LCR, average water temperatures would only meet or exceed minimum spawning, egg incubation and growth requirements during July (end of spawning season) under the 10th percentile conditions for the proposed action, which is also not different from current conditions. However, during 10th percentile years, the average water temperature near the LCR would be slightly warmer (less than 0.8°F) for the proposed action in most months. During 50th percentile years, average water temperature near the LCR would also be slightly warmer from April through August. These warmer water temperatures could benefit humpback chub when life stage minimum temperature thresholds are exceeded, and could help to minimize thermal shock to young-of-year humpback chub entering the

mainstem from the LCR. Although under 50th percentile conditions, the Colorado River near the LCR confluence would be colder from September through March under the proposed action; average monthly water temperatures are predicted to be less than 1.2°F colder than under current conditions. Although average monthly water temperatures during these months would be less than that required for growth (60.8°F) under both current and proposed action conditions, so the net affect to humpback chub should not be significant.

At the Diamond Creek confluence, average water temperatures could be up to 1.12°F warmer during 10th percentile years for the proposed action than for current conditions in most months, which may benefit humpback chub, with optimal spawning, incubation and growth temperatures attained earlier in the year, although the maximum temperature for growth (71.6°F) may be approached more frequently during 10th percentile years, which could result in impeded growth (because temperatures are too warm) compared to the no action. For 50th percentile conditions, average temperatures at Diamond Creek could be less than 0.8°F warmer for the proposed action than for the current conditions in April through August, and spawning could occur one month earlier (June). This could benefit humpback chub as minimum incubation and growth temperatures would also be met earlier in the year. Humpback chub are rare at Diamond Creek, but there are seven mainstem aggregations of humpback chub between the LCR and Diamond Creek. Warmer water temperatures in the river from the confluence of the LCR to Diamond Creek in some months under the proposed action could increase growth of humpback chub.

From September through March at Diamond Creek, average monthly water temperatures under 50th percentile conditions will be ~1.44°F colder for the proposed action than current conditions. Although the average monthly water temperature for the proposed action in September would be 0.64°F cooler, average water temperature will remain above the minimum growth temperature for humpback chub. From October through March, average monthly water temperatures will continue to be below the minimum growth temperature. Thus, these slightly colder water temperatures under the proposed action would adversely affect growth of the humpback chub, but to about the same extent as current conditions.

Overall, the proposed action is predicted to increase the probability of a slightly warmer river. Although the proposed action is likely to produce colder water temperatures in some years during the fall and winter, these are not significant to humpback chub survival relative to current conditions. The potential for warmer water temperatures in the spring and summer during some years could be significant in terms of meeting temperature requirements for spawning, hatching and growth.

The warmer water caused by the proposed action could affect the aquatic food base downstream of Glen Canyon Dam. However, common aquatic invertebrates including larval chironomids, larval simuliids, and Gammarus, as well as Cladophora (an algae) are key components of the aquatic food base downstream of Glen Canyon Dam and are tolerant of a wide range in temperatures. The preferred temperature ranges for these invertebrates would not be exceeded by the warmer temperatures of the proposed action, although the preferred temperature for Cladophora could be exceeded for a longer time relative to current conditions. These extensions of warm temperatures could occur in early July and late

September near the LCR confluence and in early June and early October near Diamond Creek. However, Cladophora should remain present despite the potential for temperatures above its preferred thermal range, and invertebrates may benefit from warmer temperatures overall. The predominance of Cladophora downstream of Glen Canyon Dam also appears to be linked to water clarity; the proposed action is not anticipated to result in any significant changes in water clarity.

The slightly warmer water temperatures under the proposed action relative to current conditions could also benefit the nonnative fish species present in the river by allowing earlier reproduction and increased growth similar to that for the humpback chub in those years when such temperature increases occur. Nonnative species that are common in the river from the Paria River confluence to Lake Mead and associated tributaries include channel catfish, brown trout, rainbow trout, common carp, and fathead minnow. Red shiner, plains killifish and mosquitofish are locally common below the LCR, and channel catfish increase in abundance below RM 160 (Gloss et al. 2005). Also present in low numbers are black bullhead, yellow bullhead, and green sunfish (GCMRC, unpubl. data).

Nonnative fish could also invade the Colorado River from Lake Powell through Glen Canyon Dam. The proposed action will result in lower reservoir levels in Lake Powell overall, which increases the possibility for warmwater species in the epilimnion of Lake Powell to become entrained in the penstock intakes and enter the river through the dam. Low reservoir levels in Lake Powell from 2004-2006 resulted in warmer water being released from the dam because water from the meta- and epilimnion of Lake Powell was entering the penstocks; significant increases in warmwater nonnative species were not detected below the dam, although smallmouth bass and walleye were detected in very low numbers which could have come through the dam (GCMRC unpubl. data). Although the proposed action will result in changes to the probable reservoir elevations of Lake Powell, this is unlikely to increase the potential for invasion of nonnative fishes upstream to areas such as Cataract Canyon.

Common carp, fathead minnow, red shiner, and mosquitofish feed primarily on aquatic insects, other small invertebrates, and plant material, although they can eat fish eggs and larvae as well (Moyle 2002). The plains killifish feeds near the surface on invertebrates and algae (Colorado State 2007). The other species, at least larger individuals, are predatory (Moyle 2002). Predatory nonnative fish that are rare to uncommon in the river but common at the inflows to Lake Mead and Lake Powell including channel catfish, walleye (*Stizostedion vitreum*), striped bass (*Morone saxatilis*), and largemouth bass (*Micropterus salmoides*) will likely persist at current levels. Smallmouth bass are rare in the river, inflow areas, and Lake Mead. All but rainbow trout, brown trout, red shiner, walleye, striped bass, and smallmouth bass have minimum spawning and incubation temperatures at or above those for humpback chub and thus could benefit from slightly warmer temperatures for the proposed action.

Since many nonnative fish prey on native fish, the potentially increased number and/or feeding activity of nonnative fish at warmer temperatures could adversely affect the humpback chub. However, many species of nonnative fish are already present in this reach and the infrequent, slightly warmer water temperatures are unlikely to increase their long-

term abundance or species composition. For example, smallmouth bass generally does not establish in habitats where water temperatures do not exceed 66.2°F for extended periods in the summer (Moyle 2002). The proposed action is not expected to increase average monthly water temperatures to above 66.2°F (based on modeling results) near the LCR under any conditions. Near Diamond Creek, average water temperatures are above 66.2°F in July through September under current conditions, and the proposed action could increase these average temperatures by about 0.8°F and extend the duration of warmer temperatures by a few weeks. Thus, the proposed action would be unlikely to result in a population increase for smallmouth bass in the Colorado River between Glen Canyon Dam and Lake Mead, so long as the nonnative fish control program remains effective.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm and anchorworm in the mainstream Colorado River in some years. The potential for these parasites to infect fish increases when Glen Canyon Dam releases occur at low Lake Powell elevations (10th percentile or lower), and this could adversely affect the humpback chub. The level of effect is unknown but in isolation could be negligible considering the low frequency of such occurrences and the small increase in average temperature that would occur as a result of the proposed action; however, when combined with the aforementioned effects of habitat and nonnative fish, parasitism could be significant. Although the overall impact of Asian tapeworm is not fully understood, infestation rates can be high in humpback chub in the LCR, and may cause some level of mortality (USGS 2004, Hoffnagle 2007). If infestation rates in the mainstem were to increase, the potential increase in humpback chub mortality could be significant.

The known constituent elements of water and physical habitat will not be affected in the lower 8 miles of the LCR. However, because the proposed action could result in an increase in the presence of nonnative fish species that could invade the LCR, the proposed action could reduce the quality of critical habitat in the LCR in terms of the biological constituent element. Critical habitat from RM 34 (Nautiloid Canyon) to RM 208 (Granite Park) along the Colorado River will be affected in the ways described above. The constituent element of water will be affected via more variation in temperature and flow, and a predicted overall slight increase in water temperature. As discussed above, this could have both beneficial and adverse affects to humpback chub, by providing temperatures more conducive to spawning, rearing and growth, and also potentially increasing numbers of nonnative fish. The constituent element of physical habitat will be affected by an overall increase in flow and concomitant increase in sediment transport, as well as potentially greater daily flows, which could reduce the availability of backwaters, thought to be important rearing habitats for humpback chub. The biological environment includes food supply and habitats with levels of nonnative predators and competitors that are low enough to allow for spawning, feeding, and rearing. Increases in overall water temperature should benefit the food base of humpback chub, although levels of nonnative predators and competitors could increase in response to this temperature increase.

Reclamation has proposed a number of conservation measures to reduce the adverse affects of the proposed action and promote long-term species conservation. As listed under "Conservation Measures" in the Proposed Federal Action section, these include

implementation of nonnative fish control, creation of a humpback chub refuge, funding a genetic biocontrol symposium, funding research on sediment-related fish habitat questions, and monitoring and control of nonnative parasites.

Kanab Ambersnail

The proposed action will have no effect on the water flow from the side canyon spring that maintains wetland and aquatic habitat at Vaseys paradise. As indicated above, the proposed action includes releases of less than 8.23 maf/year under certain identified circumstances. In years where these lower annual releases occur, the typical hourly maximum flow from Glen Canyon Dam would be lower than would occur under the current minimum objective annual release of 8.23 mafy. These lower annual releases have a relatively low probability of occurring under the proposed action (about 0.26 percent for releases between 7.51 to 8.22 maf, 12 percent for releases between 7.01 to 7.50 maf and 1.05 percent for releases less than or equal to 7.0 maf). These lower flows could allow wetland vegetation to establish lower down the canyon wall during some years. This could provide a temporary increase in Kanab ambersnail habitat, though such increases would be inundated and likely scoured in subsequent years with higher annual releases and corresponding higher hourly maximum flows. Consequently, the proposed action could result in loss of snails and snail habitat if the snail occupies new habitat that is created under the proposed action and then is subsequently inundated.

In certain months of the year, the average monthly flow could exceed 17,000 cfs. These higher flows (90th percentile) would inundate a larger area of Kanab ambersnail habitat than under current conditions, most likely in April and May. Conversely, average monthly flows above 17,000 cfs in other months (e.g., July) are less frequent under the 90th percentile for the proposed action compared to current conditions. Consequently, the proposed action could result in some level of loss of Kanab ambersnails and their habitat from increased scour that is greater than that expected under current conditions in some months. These losses are not expected to result in impacts to the long-term conservation of the species.

Reclamation has committed to continuing to survey for Kanab ambersnails to assess species status, as well as the effects of the proposed action.

Southwestern Willow Flycatcher and its Critical Habitat

Lake Powell to Lake Mead Reach of the Colorado River

In the Grand Canyon, the proposed action may affect and is likely to adversely affect the southwestern willow flycatcher through occasional, temporary desiccation of occupied habitat. In the Virgin and Muddy rivers, SNWA's interdependent action is not likely to adversely affect the southwestern willow flycatcher and its critical habitat.

Potential southwestern willow flycatcher habitat does not occur below the full pool of Lake Powell due to the steep topography and fluctuating nature of the reservoir. Southwestern willow flycatchers are known to nest in tamarisk along the Colorado River in the Grand

Canyon. The southwestern willow flycatcher can be affected by high flows through scouring and destruction of willow/tamarisk shrub nesting habitat or wetland foraging habitat. A reduction in flows could also have adverse effects on riparian and marsh vegetation, which could adversely affect southwestern willow flycatcher. In April and May, the 90th percentile flows under the proposed action are higher than current conditions. However, willow flycatcher nests in the Grand Canyon are typically above the 45,000 cfs stage (Gloss et al. 2005), which is not approached at the 90th percentile in these months. Therefore these somewhat higher flows in April and May should not affect southwestern willow flycatcher nests in saltcedar.

Monthly low releases (10th percentile) can be lower than under current conditions, in part because this action would allow for an annual release lower than 8.23 maf under certain circumstances. These lower annual releases would result in lower hourly maximum flows as well as lower monthly low flows than current conditions. However, the probability of an annual release of less than 8.23 maf is relatively low. Southwestern willow flycatcher nests primarily in tamarisk in the lower Grand Canyon, which is common along the Colorado River in the Grand Canyon. Tamarisk is not an obligate phreatophtye and is capable of surviving lowered water levels. Therefore, the potentially lower flows associated with the proposed action are not expected to kill tamarisk and thus no loss of southwestern willow flycatcher nesting habitat is anticipated.

An important element of flycatcher nesting habitat is the presence of moist surface soil conditions. Moist surface soil conditions are maintained by overbank flow or high groundwater elevations supported by river stage. At the 50th percentile, modeled monthly releases during the breeding season (April-August) from Glen Canyon Dam under the proposed action are almost always either equal to or greater than under current conditions. Under these conditions, flycatcher habitat conditions would be expected to be the same or improved relative to current conditions. During periods of the breeding season that flows could be less than under current conditions (10th percentile flows), the potential exists for lowering of groundwater elevations adjacent to the channel to decline, which could desiccate occupied nesting habitat, resulting in a reduction in habitat quality, such as a loss of insect prey base.

Flycatcher occurrence along the river corridor in the Grand Canyon has been low. Only one to five territories of breeding southwestern willow flycatcher were observed between 1992 and 2003 in any one year in upper Grand Canyon (Gloss et al. 2005). These occurrences have been in riparian vegetation between river miles 28 and 71. Given the ephemeral nature of flycatcher occurrence, this could change over the course of the proposed action. Reclamation has committed to continuing to survey for flycatchers and flycatcher habitat to assess species status, as well as the effects of the proposed action.

Interdependent and Interrelated Actions – Southern Nevada Water Authority's Virgin and Muddy Rivers Tributary Conservation ICS Project

Interdependent and interrelated actions are defined as those actions having no independent utility from the proposed action (50 CFR §402.02) and actions that are part of a larger action

and depend on the larger action for their justification (50 CFR § 402.02) respectively. The following is an analysis of the SNWA's proposal to utilize ICS to conserve water from the Virgin and Muddy rivers, an interdependent action associated with the proposed action.

The potential effects to the southwestern willow flycatcher from SNWA's proposed Virgin and Muddy rivers tributary conservation ICS project are described in Attachment B to the biological assessment. A determination was made that SNWA's proposed project may affect, but is not likely to adversely affect the southwestern willow flycatcher given that the proposed project will have minor beneficial effects to the species and riparian habitat that supports the species along the Virgin and Muddy Rivers. The beneficial effects will be realized through maintenance of tributary conservation flows in the irrigation ditches that supports existing nesting and foraging habitat for the species, especially nesting habitat located at existing agricultural returns. In addition, nesting or foraging habitat for the species may be enhanced or newly developed through any increase in tributary conservation flows that may remain in the main channel of the Virgin and Muddy rivers. These beneficial effects are difficult to measure in terms of direct benefit of the tributary conservation flows versus other river flows to the species and its habitat, and thus, these beneficial effects are considered negligible.

The potential effects to designated critical habitat for the southwestern willow flycatcher from SNWA's proposed Virgin and Muddy rivers tributary conservation ICS project are described in Attachment B to the biological assessment (U.S. Bureau of Reclamation 2007c). SNWA's proposed project will likely result in minor beneficial effects to the primary constituent elements that support critical habitat for the species in the SNWA proposed project area along the Virgin River. The beneficial effects will be realized through maintenance of tributary conservation flows in the irrigation ditches that supports the primary constituent elements for the species, including native riparian vegetation for nesting, and saturated soils that provides the prey base. Additionally, nesting or foraging habitat for the species may be enhanced or newly developed through any increase in tributary conservation flows that may remain in the main channel of the Virgin River. These beneficial effects are difficult to measure in terms of direct contribution of the tributary conservation flows versus the contribution of other river flows to the primary constituent elements for the species, and thus, these beneficial effects are considered negligible.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Native American use of the Colorado River in Grand Canyon includes cultural, religious, and recreational purposes, as well as land management of tribal lands (e.g. recreational use including rafting and hunting and fishing). Nonfederal actions on the Virgin and Muddy rivers are limited to small developments, private water diversions and recreation. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Since a significant portion of the project area is on Federal lands, all legal actions likely to occur would be considered Federal actions, and would be subject to additional section 7 consultation.

CONCLUSION

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.[1]

After reviewing the current status of the humpback chub and its critical habitat, the current status of the southwestern willow flycatcher and its critical habitat, the current status of the Kanab ambersnail, the environmental baseline for the action area, the effects of implementation of the proposed Guidelines, and the cumulative effects, it is our biological opinion that implementation of the Guidelines, as proposed, is not likely to jeopardize the continued existence of the humpback chub, the southwestern willow flycatcher, or the Kanab ambersnail, and is not likely to destroy or adversely modify designated critical habitat for the humpback chub or the southwestern willow flycatcher.

We present this conclusion for the humpback chub and its critical habitat for the following reasons:

- In 1995, in a consultation on the operations of Glen Canyon Dam, specifically on the MLFF, we anticipated that operation of Glen Canyon Dam (the monthly, daily, and hourly operation as defined in the MLFF and the 1996 ROD) would jeopardize the continued existence of the species. Although populations in the upper Colorado River basin have declined as of November 2007, the Grand Canyon population, which was the population analyzed in the 1995 biological opinion, appears to have recently improved to around 6,000 adult fish. Although this is less than the number of adult fish thought to be present in Grand Canyon in 1995, and indeed the status of the species is reduced overall from what it was in 1995, we do not believe Reclamation's proposed action analyzed in this biological opinion will jeopardize the continued existence of the species because the action is predicted to have beneficial effects (improved temperature-related survivorship and growth), and although the proposed action is also predicted to have adverse effects (primarily via the risk of potentially increased numbers of nonnative fishes) to humpback chub, Reclamation is implementing conservation measures, through the AMP, to reduce this threat. The suite of conservation measures increases our confidence in our opinion that all adverse affects of the proposed action are reduced to the point that the action will not jeopardize the species or result in adverse modification of critical habitat.

- Reclamation has committed to conservation measures including the following:

    - Nonnative Fish Control – In coordination with other DOI AMP participants and through the AMP, Reclamation will ensure that efforts continue to control both cold- and warm-water nonnative fish species in the mainstem of Marble and Grand canyons, including determining and implementing levels of

[1] See the December 27, 2004, memo from Acting Director, Fish and Wildlife Service.

nonnative fish control as necessary. Control of these species using mechanical removal and other methods will help to reduce this threat.

- Humpback Chub Refuge – Reclamation will assist FWS in development and funding of a broodstock management plan and creation and maintenance of a humpback chub refuge population at a Federal hatchery or other appropriate facility by providing expedited advancement of $200,000 in funding to the FWS during CY 2008; this amount shall be funded from, and within, the amount identified in the MSCP BCO. Creation of a humpback chub refuge will reduce or eliminate the potential for a catastrophic loss of the Grand Canyon population of humpback chub by providing a permanent source of genetically representative stock for repatriating the species.

- Genetic Biocontrol Symposium – Reclamation will transfer up to $20,000 in fiscal year 2008 to FWS to help fund an international symposium on the use and development of genetic biocontrol of nonnative invasive aquatic species which is tentatively scheduled for January 2009. Although only in its infancy, genetic biocontrol of nonnative species is attracting worldwide attention as a potential method of controlling aquatic invasive species. Helping fund an effort to bring researchers together will further awareness of this potential method of control and help mobilize efforts for its research and development.

- Sediment Research – In coordination with other DOI AMP participants and through the AMP, Reclamation will monitor the effect of sediment transport on humpback chub habitat and will work with the GCMRC to develop and implement a scientific monitoring plan acceptable to FWS. Although the effects of dam operation-related changes in sediment transport on humpback chub habitat are not well understood, humpback chub are known to utilize backwaters and other habitat features that require fine sediment for their formation and maintenance. Additional research will help clarify this relationship.

- Parasite Monitoring – In coordination with other DOI AMP participants and through the AMP, Reclamation will continue to support research on the effects of Asian tapeworm on humpback chub and potential methods to control this parasite. Continuing research will help better understand the degree of this threat and the potential for management actions to minimize it.

- We believe critical habitat will remain functional and continue to serve the intended conservation role for the humpback chub because there are expected to be some beneficial effects from the proposed action (improved temperature-related survivorship and growth) and the suite of conservation measures implemented by Reclamation will serve to minimize adverse effects of the proposed action (primarily via the risk of potentially increased numbers of nonnative fishes) to humpback chub by implementing measures to control and plan for the control of nonnative species.

We present this conclusion for the Kanab ambersnail for the following reasons:

- Although implementation of the Guidelines will create a more variable river, and this variation may result in the loss some Kanab ambersnails and their habitat, we anticipate this loss will not impair the long-term stability of the population, because the action is predicted to result in only small, temporary losses of Kanab ambersnail habitat (due to inundation and scouring) over the course of the proposed action.

- Additionally, Reclamation has committed to the following conservation measure:

    - Monitoring and Research – Through the AMP, Reclamation will continue to monitor Kanab ambersnail and its habitat in Grand Canyon and the effect of dam releases on the species, and Reclamation will also continue to assist FWS in funding morphometric and genetic research to better determine the taxonomic status of the subspecies.

We present this conclusion for the southwestern willow flycatcher and its critical habitat for the following reasons:

- Southwestern willow flycatchers are rare in Grand Canyon, and although the implementation of the proposed action may adversely affect the species in some years by reducing habitat quality via reduced flow, this effect will not be permanent and will affect a very small portion of the overall range of the flycatcher. Additionally, through the AMP, Reclamation will continue to monitor southwestern willow flycatcher and its habitat and the effect of dam releases on the species throughout Grand Canyon and report findings to FWS, and will work with the NPS and other AMP participants to identify actions to conserve the flycatcher.

- Along the Virgin and Muddy rivers, effects to the southwestern willow flycatcher and designated critical habitat from SNWA's proposed Virgin and Muddy Rivers Tributary Conservation ICS Project should be mostly beneficial, due to increased flow in these rivers, but this effect is considered negligible.

- Critical habitat will not be adversely affected on the Virgin and Muddy rivers, because the net effect of the SNWA project should be mostly beneficial, due to increased flow in the Virgin and Muddy rivers, but this effect is considered negligible.

The conclusions of this biological opinion are based on full implementation of the project as described in the Description of the Proposed Action section of this document, including any Conservation Measures that were incorporated into the project design.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 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 to be prohibited taking under the Act, 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 undertaken by Reclamation so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Humpback chub

The level of take that could occur from the proposed action would result from the unintentional beneficial conditions to nonnative fish that result in subsequent competition with or predation on humpback chub, the beneficial effects to Asian tapeworm that could cause increased parasitism, and increased mortality of young humpback chub due to a reduction in the quality of mainstem nearshore habitat. Take from these effects is reasonably certain to occur over the long life of the proposed action (to 2026), but the anticipated level of take of humpback chub from these effects is unquantifiable because of the rarity of the species in much of the action area, 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. We anticipate, however, that due to the fact that most adverse effects to humpback chub are predicted to occur during low-probability hydrologic scenarios (i.e. the 10th percentile), and Reclamation is implementing a list of conservation measures to study and minimize these effects as part of its proposed action, take of humpback chub from the proposed action is anticipated to occur

to only a small portion of the population and is not expected to result in a decline in the overall Grand Canyon population. As a surrogate measure of take, we will consider anticipated take to be exceeded if the proposed action results in an increase in nonnative species and subsequent decrease in the status of the humpback chub, despite efforts by Reclamation through the AMP to control nonnative fish species; specifically: (1) a 50 percent increase in nonnative fish species abundance in the mainstem Colorado River at the confluence of the LCR from 2007 levels; and (2) efforts to control nonnative fish species by Reclamation in collaboration with GCMRC and other DOI agencies and AMP participants are ineffective such that the increase persists over a consecutive 5-year period; and (3) during this consecutive 5-year period, monitoring indicates a significant decline in humpback chub recruitment or survivorship that is solely attributable to the proposed action.

Kanab Ambersnail

The level of take of Kanab ambersnail that could occur from the proposed action would be due to the scouring of habitat and snails from high flows or high flows following a period of low flows. Take from these effects is reasonably certain to occur over the long life of the proposed action (to 2026). However, given the potential range of flows that could occur, it is not possible to quantify an amount of habitat or number of snails that could be lost. We anticipate, however, that the amount of loss would be small, and will not impair the long-term stability of the population. As a surrogate measure of take, we will consider anticipated take to be exceeded if the proposed action results in a long-term decrease in the amount of Kanab ambersnail habitat; specifically: (1) ongoing monitoring by Reclamation, in collaboration with GCMRC and other DOI agencies and AMP participants, reveals that there is a reduction of the amount of Kanab ambersnail habitat present at Vaseys Paradise of more than 20 percent from 2007 that is solely attributable to the proposed action; and (2) efforts to prevent habitat loss by Reclamation, in collaboration with other AMP participants, prove ineffective such that this reduction in Kanab ambersnail habitat at Vaseys Paradise continues over a 5-year period.

Southwestern Willow Flycatcher

Due to the low number of flycatchers in Grand Canyon, the limited scope of adverse effects, and the implementation of the conservation measures of the proposed action for this species, we do not anticipate that the proposed action will result in incidental take of southwestern willow flycatcher.

For the Virgin and Muddy rivers, the effects to southwestern willow flycatcher from SNWA's proposed Virgin and Muddy Rivers Tributary Conservation ICS Project are considered negligible and not likely to rise to the level of incidental take.

EFFECT OF THE TAKE

In this biological opinion, we determine that this level of anticipated take is not likely to result in jeopardy to the humpback chub or Kanab ambersnail. The implementation of the proposed action will ensure that, while incidental take may still occur, it is minimized to the

extent that habitat quality and quantity will be maintained in the planning area, and the species will be conserved.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

Humpback Chub

The following reasonable and prudent measure is necessary and appropriate to minimize take of humpback chub:

> Monitor the effects of the proposed action on humpback chub and its habitat to document levels of incidental take and report the findings to the FWS. Reclamation shall work in collaboration with the AMP participants including GCMRC and other cooperators to complete this monitoring.

The following term and condition will implement this reasonable and prudent measure:

> Reclamation, in collaboration with the AMP participants including the GCMRC and other cooperators, shall submit a written report to the FWS annually documenting activities of the proposed action for the year that resulted in documented take. The report will include a discussion of the progress of the implementation of Reclamation's conservation measures included in the proposed action.

Kanab Ambersnail

The following reasonable and prudent measure is necessary and appropriate to minimize take of Kanab ambersnail:

> Monitor the effects of the proposed action on Kanab ambersnail and its habitat to document levels of incidental take and report the findings to the FWS. Reclamation shall work in collaboration with the AMP participants including GCMRC and other cooperators to complete this monitoring.

The following term and condition will implement this reasonable and prudent measure:

> Reclamation, in collaboration with the AMP participants including GCMRC and other cooperators, shall submit a written report to the FWS annually documenting activities of the proposed action for the year that resulted in documented take. The report will include a discussion of the progress of the implementation of Reclamation's conservation measures included in the proposed action.

Southwestern Willow Flycatcher

Due to the implementation of the conservation measures of the proposed action for this species, no reasonable and prudent measures are necessary. Reclamation has committed to assisting NPS in providing FWS with annual survey information for the flycatcher in Grand Canyon.

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

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species, initial notification must be made to the FWS's Law Enforcement Office (2450 West Broadway Road, Suite 113, Mesa, Arizona, 85202, telephone: 480/967-7900) 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 if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office. Care must be taken in handling sick or injured animals to ensure effective treatment and care and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans or to develop information.

Humpback Chub

FWS recommends that Reclamation continue working with FWS to achieve the revised recovery goals for humpback chub when they become available in 2008.

Kanab Ambersnail

FWS recommends that Reclamation continue to work with FWS to implement the "Interim Conservation Plan for the Oxyloma (haydeni) kanabensis Complex and Related Ambersnails in Arizona and Utah" (AGFD 2002).

Southwestern Willow Flycatcher

FWS recommends that Reclamation continue to work with FWS to implement the recovery plan for the southwestern willow flycatcher.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in your request. 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 retained (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 your efforts to identify and minimize effects to listed species from this project. For further information, please contact Glen Knowles (602) 242-0210 or (x233) or Steve Spangle (602) 242-0210 (x244). Please refer to consultation number (22410-2006-F-0224) in future correspondence concerning this project.

Steven L. Spangle

cc: Area Manager, Upper Colorado Regional Office, Salt Lake City, UT
Regional Director, Fish and Wildlife Service, Albuquerque, NM
Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ
Field Supervisor, Fish and Wildlife Service, Reno, NV
Director, Environmental Programs, Bureau of Indian Affairs, Phoenix, AZ
Ak-Chin Indian Community, Maricopa, AZ
Chemehuevi Indian Tribe, Havasu Lake, CA
Cocopah Tribe, Somerton, AZ
Colorado River Indian Tribes, Parker, AZ

Fort McDowell Yavapai Nation, Fountain Hills, AZ
Fort Mohave Indian Tribe, Needles, AZ
Gila River Indian Community, Sacaton, AZ
Havasupai Tribe, Peach Springs, AZ
Hopi Tribe, Kykotsmovi, AZ
Hualapai Tribe, Supai, AZ
Kaibab Band of Paiute Indians, Pipe Springs, AZ
Navajo Nation, Window Rock, AZ
Pascua Yaqui Tribe, Tucson, AZ
Pueblo of Zuni, Zuni, NM
Ft. Yuma Quechan Tribe, Yuma, AZ
Salt River Pima-Maricopa Indian Community, Scottsdale, AZ
San Juan Southern Paiute Tribe, Tuba City, AZ
San Carlos Apache, San Carlos, AZ
Tohono O Odham Nation, Sells, AZ
Tonto Apache Reservation, Payson, AZ
White Mountain Apache Tribe, Whiteriver, AZ
Yavapai Apache Nation, Camp Verde, AZ
Yavapai Prescott Indian Tribe, Prescott, AZ

LITERATURE CITED

Ackerman, M.W. 2007. 2006 Native fish monitoring activities in the Colorado River, Grand Canyon. Cooperative Agreement (04WRAG0030) Report to U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona. 79 p.

Albrecht, B., T. Sanderson and P.B. Holden. 2007a. Razorback sucker studies on Lake Mead, Nevada and Arizona 2006-2007. BIO-WEST, Inc., Annual Report to U.S. Bureau of Reclamation, Boulder City, Nevada, PR-1093-1. 60 p.

Albrecht, B., M.E. Golden, and P.B. Holden. 2007b. Lower Virgin River Long-term Monitoring 2003-2005. BIO-WEST, Inc., Final Report to Southern Nevada Water Authority, Las Vegas, Nevada, PN-1040-01. 43 p.

Arizona Game and Fish Department. 1996. Ecology of Grand Canyon backwaters. Cooperative Agreement Report (9-FC-40-07940) to Glen Canyon Environmental Studies, Flagstaff, Arizona. 165 p.

Berry, C.R. 1988. Effects of cold shock on Colorado River Squawfish larvae. Southwestern Naturalist 33(2): 193-197.

Berry, C.R., and R. Pimentel. 1985. Swimming performances of three rare Colorado River fishes. Transactions of the American Fisheries Society 114: 397-402.

Blinn, D.W., and G.A. Cole. 1991. Algal and Invertebrate Biota in the Colorado River: Comparison of Pre-and Post-Dam Conditions. Pages 102-123 *in* Pages 40-53 *in* Colorado River Ecology and Dam Management. Proceedings of a symposium, May 24-25, 1990. National Academy Press, Washington, DC.

Braden, G.T., Miller, A., and Crew, L. 2006. The status of the Yuma clapper rail and the yellow-billed cuckoo along portions of the Virgin River and Muddy River in Southern Nevada: 2005. San Bernardino County Museum, Redlands, California. Report to U.S. Fish and Wildlife Service Southern Nevada Field Office, Las Vegas, Nevada, and Southern Nevada Water Authority, Las Vegas, Nevada. 20 p.

Brouder, M.J., and T.L. Hoffnagle. 1997. Distribution and prevalence of the Asian tapeworm, Bothriocephalus acheilognathi, in the Colorado River and tributaries, Grand Canyon, Arizona, including two new host records. Journal of Helminthological Society of Washington 64:219–226.

Brown, B.T. 1988a. Breeding ecology of a willow flycatcher population in Grand Canyon, Arizona. Western Birds 19:25-33.

Brown, B.T. 1988b. Monitoring bird population densities along the Colorado River in Grand Canyon: 1987 breeding season. Final Report to the Glen Canyon Environmental Studies, Bureau of Reclamation, Salt Lake City, Utah. 26 p.

Brown, B.T. 2004. Southwestern willow flycatcher surveys along the Virgin River near Mesquite, Nevada, 2004. SWCA Environmental Consultants. Report to Bureau of Land Management, Las Vegas, Nevada. 24 p.

Browning, M.R. 1993. Comments on the taxonomy of Empidonax traillii (willow flycatcher). Western Birds 24:241-257.

Chart, T.E., and L. Lentsch. 2000. Reproduction and recruitment of Gila spp. and Colorado pikeminnow (*Ptychocheilus lucius*) in the middle Green River; 1992–1996. Utah Division of Wildlife Resources, publication number 00-18. Final Report to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Christensen, K. 2007. Southwestern willow flycatcher surveys in lower Grand Canyon, Fiscal Year 2007. Department of Natural Resources, Hualapai Tribe. Final Report to U.S. Bureau of Reclamation, Boulder City, Nevada.

Christensen, N. and D.P. Lettenmaier. 2006. A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River basin. Hydrology and Earth System Sciences Discussion 3:1-44.

Clarke, A.H. 1991. Status survey of selected land and freshwater gastropods in Utah. U.S. Fish and Wildlife Service Report. Denver, Colorado.

Clarkson, R.W., and M.R. Childs. 2000. Temperature effects of hypolimnial-release dams on early life stages of Colorado River Basin big-river fishes. Copeia 2000: 402–412.

Clarkson, R.W., A.T. Robinson, and T.L. Hoffnagle. 1997. Asian tapeworm (*Bothriocephalus acheilognathi*), in native fishes from the Little Colorado River, Grand Canyon, Arizona. Great Basin Naturalist 57: 66–69.

Colorado State. 2007. Plains Killifish. Available at: http://waterknowledge.colostate.edu/plainski.htm. Accessed 25 July 2007.

Coggins, L.G., Pine, W.E., III, Walters, C.J., Van Haverbeke, D.R., Ward, D., Johnstone, H.C. 2006. Abundance trends and status of the Little Colorado River population of humpback chub. North American Journal of Fisheries Management (26): 233–245.

Dawdy, D.R. 1991. Hydrology of Glen Canyon and Grand Canyon. Pages 40-53 *in* Colorado River Ecology and Dam Management. Proceedings of a symposium, May 24-25, 1990. National Academy Press, Washington, DC.

DeLoach, C.J. 1991. Saltcedar, an exotic weed of western North American riparian areas: a review of its taxonomy, biology, harmful and beneficial values, and its potential for biological control. Contract No. 7-AG-30-04930. Report to the Bureau of Reclamation, Boulder City, Nevada.

Douglas, M.E., and P.C. Marsh. 1996. Population estimates/population movements of Gila cypha, an endangered cyprinid fish in the Grand Canyon region of Arizona. Copeia 1996: 15–28.

Durst, S.L., M.K. Sogge, H.C. English, S.O. Williams, B.E. Kus, and S.J. Sferra. 2006. Southwestern willow flycatcher breeding site and territory summary – 2005. U.S. Geological Survey, Colorado Plateau Research Station, Flagstaff, AZ.

English, H.C., A.E. Graber, S.D. Stump, H.E. Telle, and L.A. Ellis. 2006. Southwestern willow flycatcher 2005 survey and nest monitoring report. Nongame and Endangered Wildlife Program Technical Report 248. Arizona Game and Fish Department, Phoenix, Arizona.

Finney, S,T. Modde, B. Haines, and K. Christopherson. 2004. Yampa Canyon Population of Humpback Chub: Past, Present, and Future. U.S. Fish and Wildlife Service. Presentation at Population Estimates Workshop II, August 24-25, 2004, Grand Junction, Colorado.

Gloss, S.P., Lovich, J.E., and Melis, T.S., eds. 2005. The state of the Colorado River ecosystem in Grand Canyon: U.S. Geological Survey Circular 1282, Reston, Virginia. 220 p.

Goeking, S. A., J. C. Schmidt, and M. K. Webb. 2003. Spatial and temporal trends in the size and number of backwaters between 1935 and 2000, Marble and Grand Canyons, Arizona. Department of Aquatic, Watershed, and Earth Resources. Utah State University. Report prepared for U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona.

Golden, M.E. and P.B. Holden. 2002. Fish need water! Low flow impacts on the native fish of the Virgin River. Abstract. 34th Annual Meeting of the Desert Fishes Council, San Lois Potosi, Mexico.

Golden, M.E., and P.B. Holden. 2003. 2003 annual report for fisheries surveys of the Virgin River. Prepared for the U.S. Fish and Wildlife Service, Las Vegas, Nevada by BIO-WEST, Inc., Logan, Utah. 4 p.

Golden, M.E. and P.B. Holden. 2004. Summary of Lower Virgin River studies 1996-2002, Final Report. BIO-WEST Report PR-449-2. Prepared for the Southern Nevada Water Authority, Las Vegas, Nevada.

Gorman, O.T., and D.M. Stone. 1999. Ecology of spawning humpback chub (*Gila cypha*) in the Little Colorado River near Grand Canyon, Arizona. Environmental Biology of Fishes 55: 115–133.

Hamman, R.L. 1982. Spawning and culture of humpback chub. Progressive Fish-Culturist 44: 213–216.

Hanna, W.C. 1928. Notes on the dwarf cowbird in southern California. Condor 30: 161-162.

Hoerling, M. and J. Eischeid. 2006. Past peak water in the Southwest. Southwest Hydrology 6(1).

Hoffnagle, T.L. 2000. Humpback chub *Gila cypha* health and parasites, 1998–1999. Arizona Game and Fish Department. Final Report to U.S. Fish and Wildlife Service, Grand Canyon Fishery Resource Office, Flagstaff, Arizona.

Holden, P.B., and M.E. Golden. 2000. 2000 Annual report for fisheries survey of the Virgin River. BIO/WEST, Inc. Report to the U.S. Fish and Wildlife Service, Las Vegas, Nevada.

Holden, P.B., M.E. Golden, and S.J. Zucker. 2001. An evaluation of changes in woundfin (*Plagopterus argentissimus*) populations in the Virgin River, Utah, Arizona, and Nevada, 1976-1999. Report PR-735-1. BIO-WEST, Inc., Logan, Utah. 77 p.

Howard, A., and R. Dolan. 1981. Geomorphology of the Colorado River in the Grand Canyon. Journal of Geology 89:269–298.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press, New York, New York. 851 p.

Intergovernmental Panel on Climate Change. 2007. Summary for Policymakers, *in* Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, New York, USA.

Jackson, J. 2004a. Westwater Canyon Humpback Chub Population Estimates. Utah Division of Wildlife Resources. Presentation at Population Estimates Workshop II, August 24-25, 2004, Grand Junction, Colorado.

Jackson, J. 2004b. Desolation and Gray Canyon Humpback Chub Population Estimate 2001-2003. Utah Division of Wildlife Resources. Presentation at Population Estimates Workshop II, August 24-25, 2004, Grand Junction, Colorado.

James, M.A. 2005. Final biological assessment; Colorado River Management Plan. Grand Canyon National Park, National Park Service. 69 pp + appendices.

Johnstone, H.C. and M.V. Lauretta. 2007. Native fish monitoring activities in the Colorado River during 2004 Annual report. Cooperative agreement 04WRAG0011. Report to U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona. 85 p.

Kaeding, L.R. and M.A. Zimmerman. 1983. Life history and ecology of the humpback chub in the Little Colorado and Colorado rivers of the Grand Canyon. Transactions of the American Fisheries Society. 112: 577-594.

Kaeding, L.R., B.D. Burdick, P.A. Schrader, and C.W. McAda. 1990. Temporal and spatial relations between the spawning of humpback chub and roundtail chub in the Upper Colorado River. Transactions of the American Fisheries Society 119: 135-144.

Karp, C.A., and Tyus, H.M. 1990. Humpback chub (*Gila cypha*) in the Yampa and Green rivers, Dinosaur National Monument, with observations on roundtail chub (G. robusta) and other sympatric fishes. Great Basin Naturalist 50: 257–264.

Korman, J, S.M. Wiele, and M. Torizzo. 2004. Modelling effects of discharge on habitat quality and dispersal of juvenile humpback chub (*Gila cypha*) in the Colorado River, Grand Canyon. Regulated Rivers 20: 379-400.

Korn, J. and B. Vernieu. 1998. Mainstem and tributary temperature modeling in Grand Canyon Arizona. U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

Lanigan, S.H., and H.M. Tyus. 1989. Population size and status of the razorback sucker in the Green River basin, Utah and Colorado. North American Journal of Fisheries Management 9: 68–73.

Ligon, J.S. 1961. New Mexico Birds and where to find them. The University of New Mexico Press, Albuquerque, New Mexico. 360 p.

Maddux, H.R., D.M. Kubly, J.C. DeVos Jr., W.R. Persons, R. Staedicke, and R.C. Wright. 1987. Effects of varied flow regimes on aquatic resources of Glen and Grand Canyons. Arizona Game and Fish Department. Final Report to Bureau of Reclamation, Salt Lake City, Utah.

Marsh, P.C. 1985. Effect of incubation temperature on survival of embryos of native Colorado River fishes. Southwestern Naturalist 30: 129–140.

Marsh, P.C., and M.E. Douglas. 1997. Predation by introduced fishes on endangered humpback chub and other native species in the Little Colorado River, Arizona. Transactions of the American Fisheries Society 126: 343–346.

Mayfield, H.F. 1977a. Brown-headed cowbird: agent of extermination? American Birds 31: 107-113.

Mayfield, H.F. 1977b. Brood parasitism: reducing interactions between Kirtland's warblers and brown-headed cowbirds. Chapter 11 in Endangered birds: management techniques for preserving threatened species (S.A. Temple, ed.). University of Wisconsin Press, Madison Wisconsin.

Maynard, W.R. 1995. Summary of 1994 survey efforts in New Mexico for southwestern willow flycatcher (Empidonax traillii extimus). Contract # 94-516-69. New Mexico Department of Game and Fish, Sante Fe, New Mexico. 48 p.

McAda, C.W. 2004. Black Rocks Humpback Chub Population Estimate 2003. U.S. Fish and Wildlife Service. Presentation at Population Estimates Workshop II, August 24-25, 2004, Grand Junction, Colorado.

McCarthey T.D., C.E. Paradzick, J.W. Rourke, M.W. Sumner, and R.F. Davidson. 1998. Arizona Partners In Flight southwestern willow flycatcher survey: 1997 Survey and Nest Monitoring Report. Arizona Game and Fish Department Technical Report. Nongame Branch, Arizona Game and Fish Department, Phoenix, AZ.

McGuinn-Robbins, D.K. 1997. Number and area of backwaters associated with the Colorado River in Glen, Marble and Grand Canyons, Arizona, 1990-1995. Arizona Game and Fish Department, Phoenix, Arizona.

McLeod, M.A., T.J. Koronkiewicz, B.T. Brown, and S.W. Carothers. 2007. Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2006. SWCA Environmental Consultants. Annual report to U.S. Bureau of Reclamation, Boulder City, Nevada. 194 p.

Meko, D., Woodhouse, C., Baisan, C., Knight, T., Lukas, J., Hughes, M., and Salzer, M., 2007. Medieval drought in the upper Colorado River basin. Geophysical Research Letters 34.

Melis, T.S., Martell, S.J.D., Coggins, L.G., Pine, W.E., III, and Andersen, M.E. 2006. Adaptive management of the Colorado River ecosystem below Glen Canyon Dam, Arizona: using science and modeling to resolve uncertainty in river management, *in* Specialty Summer Conference on Adaptive Management of Water Resources, CD-ROM Proceedings (ISBN 1-882132-71-8). American Water Resources Association, Middleburg, Virginia.

Melis, T.S., J.F. Hamill, M.E. Andersen, H.C. Fairley, D.J. Topping, A.E. Draut, D.M. Rubin, S.A. Wright, B.E. Ralston, T.A. Kennedy, L.G. Coggins, W.S. Vernieu, W.Cross, R. Hall, and E. Rosi-Marshall. 2007. Science plan for future experimental beach/habitat-building flows released from Glen Canyon Dam. U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona. 87 p.

Meretsky, V.J., R.A. Valdez, M.E. Douglas, M.J. Brouder, O.T. Gorman, and P.C. Marsh. 2000. Spatiotemporal variation in length-weight relationships of endangered humpback chub: implications for conservation and management. Transactions of the American Fisheries Society 129: 419–428.

Meretsky, V. and D. Wegner. 1999. Kanab ambersnail at Vaseys Paradise, Grand Canyon National Park, 1998 monitoring and research. Report to SWCA, Inc., Flagstaff, Arizona. 9 p.

Miller, R.R. 1946. Gila cypha, a remarkable new species of cyprinid fish from the Colorado River in Grand Canyon, Arizona. Journal of the Washington Academy of Sciences 36: 409-415.

Miller, R.R. 1955. Fish remains from archaeological sites in the lower Colorado River basin, Arizona. Papers of the Michigan Academy of Science, Arts, and Letters XL: 125-136.

Minckley, W.L. 1991. Native fishes of the Grand Canyon region: An obituary? Pages 124-177 *in* Pages 40-53 *in* Colorado River Ecology and Dam Management. Proceedings of a symposium, May 24-25, 1990. National Academy Press, Washington, DC.

Minckley, W.L., D.A. Hendrickson, and C.E. Bond. 1986. Geography of western North American freshwater fishes: Descriptions and relations to intracontinental tectonism. Pages 519-613 *in* Zoogeography of North American freshwater fishes, C.H. Hocutt and E.O. Wiley, eds. John Wiley and Sons, New York.

Moyle, P.B. 2002. Inland fishes of California. 2nd edition. University of California Press, Davis, CA.

Mueller, G.A. and P.C. Marsh. 2002. Lost, a desert river and its native fishes: A historical perspective of the Lower Colorado River. U.S. Geological Survey Information and Technology Report 2002-0010, Denver, Colorado. 69 p.

Muiznieks, B.D., S.J. Sferra, T.E. Corman, M.K. Sogge, and T.J. Tibbitts. 1994. Arizona Partners In Flight southwestern willow flycatcher survey, 1993. Draft report: Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona. 28 p.

Muth, R.T., L.W. Crist, K.E. LaGory, J.W. Hayse, K.R. Bestgen, T.P. Ryan, J.K. Lyons, and R.A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Final Report to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Nevada Department of Wildlife. 2001. Program Activities Report- January 1, 2000 through December 31, 2000. Nevada Division of Wildlife, Southern Region, Native Fish and Amphibian Program, Las Vegas, Nevada.

Nevada Department of Wildlife. 2007. Southwestern willow flycatcher and yellow-billed cuckoo 2006 survey and monitoring report for select sites in southern Nevada, Program Activities Report, 2006. 44 p.

Paukert, CP, D.L. Ward, P.J. Sponholtz, and K.D. Hilwig. 2005. Effects of repeated hoopnetting and handling on bonytail chub. Journal of Freshwater Ecology 20: 649-653.

Paukert, C.P., L.G. Coggins, and C.E. Flaccus. 2006. Distribution and movement of humpback chub in the Colorado River, Grand Canyon, based on recaptures. Transactions of the American Fisheries Society 135: 539-544.

Paxton, E., J. Owen, and M.K. Sogge. 1996. Southwestern willow flycatcher response to catastrophic habitat loss. Northern Arizona University. Report to U.S. Geological Survey, Biological Resources Division, Colorado Plateau Research Station. 12 p.

Peterson, R.T. 1990. A field guide to western birds. Third edition. Houghton Mifflin Company, Boston, Massachusetts. 432 p.

Pfeifer, F., T. Modde, C. McAda, D. Propst, and G. Birchell. 2002. Area Report for the Upper Colorado River Basin. Proceedings of the Desert Fishes Council, Volume XXXIV: 37-38.

Phillips, A.R. 1948. Geographic variation in Empidonax traillii. The Auk 65:507-514.

Pilsbry, H.A. 1948. Land Mollusca of North America. The Academy of Natural Sciences of Philadelphia Monographs II: 521-1113.

Platania, S.P., K.R. Bestgen, M.A. Moretti, D.L. Propst, and J.E. Brooks. 1991. Status of Colorado Squawfish and Razorback Sucker in the San Juan River, Colorado, New Mexico, and Utah. Southwestern Naturalist 36(1): 147-150.

Ridgely, R.S. and G. Tudor. 1994. The Birds of South America: Suboscine Passerines. University of Texas Press, Austin, Texas.

Robinson, A.T., R.W. Clarkson, and R.E. Forrest. 1998. Dispersal of larval fishes in a regulated river tributary. Transactions of the American Fisheries Society 127:722–786.

Rogers, R.S. and , A.S. Makinster. 2006. Grand Canyon Long-term Non-native Fish Monitoring, 2003 Annual Report. Report submitted to Grand Canyon Monitoring and Research Center Cooperative Agreement 02WRAG0030, February 2005.

Ruppert, J. B., and R. T. Muth. 1997. Effects of electrofishing fields on captive juveniles of two endangered cyprinids. North American Journal of Fisheries Management 17: 314–320.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. Science.10: 1126.

Sferra, S.J., R.A. Meyer, and T.E. Corman. 1995. Arizona Partners in Flight 1994 southwestern willow flycatcher survey. Final Technical Report 69. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program, Phoenix, Arizona. 46 p.

Sferra, S.J., T.E. Corman, C.E. Paradzick, J.W. Rourke, J.A. Spencer, and M.W. Sumner. 1997. Arizona Partners in Flight southwestern willow flycatcher survey: 1993-1996 summary report. Arizona Game and Fish Department Technical Report 113. 104 pp.

Sogge, M. K., and T. J. Tibbitts. 1992. Southwestern willow flycatcher (Empidonax traillii extimus) surveys along the Colorado River in Grand Canyon National Park and Glen Canyon National Recreation Area. NPS CPSU/N. Arizona University, Flagstaff, Arizona. 43 pp.

Sogge, M. K., and T. J. Tibbitts. 1994. Distribution and status of the southwestern willow flycatcher along the Colorado river in the Grand Canyon - 1994. Summary Report. Natl. Biol. Serv., Colorado Plateau Res. Stn./N. Arizona Univ., Flagstaff, Arizona. 37 pp.

Sogge, M. K., T. J. Tibbitts, and S. J. Sferra. 1993. Status of the southwestern willow flycatcher along the Colorado River between Glen Canyon Dam and Lake Mead - 1993. Summary Report. National Park Service, Coordinated Park Studies Unit, Northern Arizona University, U.S. Fish and Wildlife Service, and Arizona Game and Fish Department, Flagstaff, Arizona. 69 pp.

Sogge, M. K., R. M. Marshall, S. J. Sferra, and T. J. Tibbitts. 1997. A southwestern willow flycatcher survey protocol and breeding ecology summary. National Park Service, Colorado Plateau Resources Station, Northern Arizona University, Technical Report NRTR-97/12. 37 pp.

Sorenson, J.A. 2005. Kanab ambersnail 2005 progress report: status of translocated populationsand initial results from the November 2004 habitat mitigation experiment. Nongame and Endangered Wildlife Program Technical Report 243. Arizona Game and Fish Department, Phoenix, Arizona.

Sorenson, J.A. and C.B. Nelson. 2002. Interim Conservation Plan for *Oxyloma* (*haydeni*) *kanabensis* complex and related ambersnails in Arizona and Utah. Nongame and Endangered Wildlife Program Technical Report 192. Arizona Game and Fish Department, Phoenix, Arizona.

Sponholtz, P.J. and D.R. VanHaverbeke. 2007. Bright Angel Creek trout reduction project: summary report of fall 2006 weir and electrofishing efforts. Interagency Agreement R8219070736. Submitted to the Grand Canyon National Park Service, Grand Canyon National Park. 19p.

Stiles, F. G., and A. F. Skutch. 1989. A guide to the birds of Costa Rica. Comstock, Ithaca, New York. 364 pp.

Stevens, L. 1983. The Colorado River in Grand Canyon: A comprehensive guide to its natural and human history. Red Lake Books, Flagstaff, Arizona. 113 pp.

Stevens, L.E., F.R. Protiva, D.M. Kubly, V.J. Meretsky and J. Petterson. 1997a. The ecology of Kanab ambersnail (Succineidae: Oxyloma haydeni kanabensis Pilsbry, 1948) at Vaseys Paradise, Grand Canyon, Arizona: 1995 final report. Program Report, U.S. Bureau of Reclamation, Glen Canyon Environmental Studies, Flagstaff, Arizona.

Stevens, L.E., J. P. Shannon and D.W. Blinn 1997b. Colorado River benthic ecology in Grand Canyon Arizona: USA; dam, tributary and geomorphic influences. Regulated Rivers 13: 129-149.

Stevens, L.E. and T.L. Hoffnagle. 1999. Spatio-temporal changes in Colorado River backwaters downstream from Glen Canyon Dam, Arizona 1965-1997. Unpublished report available from U.S. Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff

Stone, D. M. 2006. Monitoring in 2006 of humpback chub (*Gila cypha*) and other fishes above lower Atomizer Falls in the Little Colorado River, Arizona. May 23–29 and June 28–July 3, 2006, Trip Report (USFWS-AZFRO-FL-07-002) to U.S. Geological Survey, Grand Canyon Monitoring and Research Center Flagstaff, Arizona.

Stone, D. M. 2007. Monitoring in 2007 of humpback chub (*Gila cypha*) and other Fishes above lower Atomizer Falls in the Little Colorado River, Arizona. June 1–7 and June 26–July 2, 2007 Trip Report (USFWS-AZFRO-FL-07-010) to U.S. Geological Survey, Grand Canyon Monitoring and Research Center Flagstaff, Arizona.

Stone, D.M., and O.T. Gorman. 2005. Ontogenesis of Endangered Humpback Chub (*Gila cypha*) in the Little Colorado River, Arizona. The American Midland Naturalist 155: 123-135.

SWCA. 2006. Bright Angel Creek and Roaring Springs Creek predator load survey and nonnative fish removal study. Report to National Park Service, Grand Canyon National Park.

SWCA. 2007. Tables from a Draft Report: Summary of southwestern willow flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2003 – 2007.

Topping, D.J., D.M. Rubin, and L.E. Vierra, Jr. 2000. Colorado River sediment transport 1. Natural sediment supply limitation and the influence of Glen Canyon Dam. Water Resources Research 36: 515-542.

Topping, D.J., J.C. Schmidt, and L.E. Vierra, Jr. 2003. Computation and analysis of the instantaneous-discharge record for the Colorado River at Lees Ferry, Arizona-May 8, 1921, through September 30, 2000. U.S. Geological Survey Professional Paper 1677, Reston, VA.

Trammell, M., R. Valdez, S. Carothers, and R. Ryel. 2002. Effects of a low steady summer flow experiment on native fishes of the Colorado River in Grand Canyon, Arizona. SWCA Environmental Consultants. Final Report (Contract Number 99-FC-40-2260). Report to Grand Canyon Monitoring and Research Center.

Unitt, P. 1987. Empidonax traillii extimus: An endangered subspecies. Western Birds 18:137-162.

U.S. Bureau of Reclamation. 1995. Operation of Glen Canyon Dam, final environmental impact statement. Upper Colorado Region, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1996. Operation of Glen Canyon Dam, record of decision. Upper Colorado Region, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 2007a. Colorado River interim guidelines for lower basin shortages and coordinated operations for Lake Powell and Lake Mead, draft environmental impact statement. U.S. Bureau of Reclamation, Upper and Lower Colorado River Regions. Three volumes.

U.S. Bureau of Reclamation. 2007b. Colorado River interim guidelines for lower basin shortages and coordinated operations for Lake Powell and Lake Mead, final environmental impact statement. U.S. Bureau of Reclamation, Upper and Lower Colorado River Regions. Four volumes.

U.S. Bureau of Reclamation. 2007c. Biological assessment of the Colorado River interim guidelines for lower basin shortages and coordinated operations for Lake Powell and Lake Mead, final environmental impact statement. U.S. Bureau of Reclamation, Boulder Canyon Operations Office, Boulder City, NV.

U.S. Fish and Wildlife Service. 1970. Final rule determining endangered status for the woundfin, Appendix D - United States List of Endangered Native Fish and Wildlife. Federal Register 35: 16047-16048.

U.S. Fish and Wildlife Service. 1980. Final rule determining endangered status for the bonytail chub. Federal Register 45: 27710-27713.

U.S. Fish and Wildlife Service. 1983. Yuma clapper rail recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 51 pp.

U.S. Fish and Wildlife Service. 1989. Final Rule determining endangered status for the Virgin River chub. Federal Register 54: 35305-35311.

U.S. Fish and Wildlife Service. 1990a. Humpback chub recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 43 pp.

U.S. Fish and Wildlife Service. 1990b. Bonytail chub recovery plan. Mountain-Prairie Region, Denver, CO. 35 pp.

U.S. Fish and Wildlife Service. 1991. Final rule determining endangered status for the razorback sucker. Federal Register 56: 54957-54967.

U.S. Fish and Wildlife Service. 1994. Final rule, determination of critical habitat for the Colorado River endangered fishes: razorback sucker, Colorado squawfish, humpback chub, and bonytail chub. Federal Register 59: 13375-13400.

U.S. Fish and Wildlife Service. 1995a. Kanab ambersnail (Oxyloma haydeni kanabensis) recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado.

U.S. Fish and Wildlife Service. 1995b. Final rule determining endangered status for the southwestern willow flycatcher. Federal Register 60:10694-10715.

U.S. Fish and Wildlife Service. 1995c. Virgin River fishes recovery plan. Salt Lake City, Utah. 53 pp.

U.S. Fish and Wildlife Service. 1996. Recovery Plan for the Rare Aquatic Species of the Muddy River Ecosystem, Portland, OR. 60 pp.

U.S. Fish and Wildlife Service. 1997a. Final rule, determination of critical habitat for the southwestern willow flycatcher. Federal Register 62: 39129-39146.

U.S. Fish and Wildlife Service. 1997b. Correction; final determination of critical habitat for the southwestern willow flycatcher. Federal Register 62: 44228.

U.S. Fish and Wildlife Service. 1998. Razorback sucker recovery plan. Mountain-Prairie Region, Denver, CO. 81 pp.

U.S. Fish and Wildlife Service. 2000. Final rule, designation of critical habitat for the woundfin and Virgin River chub. Federal Register 65: 4140-4156.

U.S. Fish and Wildlife Service. 2001. 12-Month finding for a petition to list the yellow-billed cuckoo in the Western Continental United States. Federal Register 66: 38611-38626.

U.S. Fish and Wildlife Service. 2002a. Humpback chub recovery goals: amendment and supplement to the humpback Chub recovery plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

U.S. Fish and Wildlife Service. 2002b. Southwestern willow flycatcher recovery plan. Region 2, Albuquerque, NM.

U.S. Fish and Wildlife Service. 2002c. Razorback sucker recovery goals: amendment and supplement to the razorback sucker recovery plan. USFWS, Mountain-Prairie Region (6) Denver, Colorado.

U.S. Fish and Wildlife Service. 2002d. Colorado Pikeminnow recovery goals: amendment and supplement to the razorback sucker recovery plan. USFWS, Mountain-Prairie Region (6) Denver, Colorado.

U.S. Fish and Wildlife Service. 2002e. Bonytail recovery goals: amendment and supplement to the razorback sucker recovery plan. USFWS, Mountain-Prairie Region (6) Denver, Colorado.

U.S. Fish and Wildlife Service. 2005a. Biological and conference opinion on the lower Colorado River multi-species conservation program, Arizona, California, and Nevada (02-21-04-F-0161). U. S. Fish and Wildlife Service, Phoenix, AZ.

U.S. Fish and Wildlife Service. 2005b. Final rule, designation of critical habitat for the southwestern willow flycatcher: Final Rule. Federal Register 70: 60886-61009.

U.S. Fish and Wildlife Service. 2006. Biological opinion on the National Park Service Colorado River management plan (02-21-89-F-0106-R1). U.S. Fish and Wildlife Service, Phoenix, Arizona.

U.S. Fish and Wildlife Service. 2007. The Virgin River fishes: woundfin (*Plagopterus argentissimus*), Virgin River chub (*Gila seminuda*), 5-year review: summary and evaluation. Draft. 43 pp.

U.S. Geological Survey. 2004. Endangered fish threatened by Asian fish tapeworm: The Asian fish tapeworm may inhibit the recovery of the humpback chub in the Grand Canyon. NWHC Information Sheet August 2004.

U.S. Geological Survey. 2006. Grand Canyon humpback chub population stabilizing. U.S. Geological Survey Fact Sheet 2006–3109 July 2006.

U.S. Geological Survey. 2007. Abundance trends and status of the Little Colorado River population of Humpback Chub: An update considering 1989 – 2006 Data. U.S. Geological Survey Open File Report 2007–1402 December 2007.

Utah Division of Wildlife Resources. 2004. Humpback chub population estimate in Cataract Canyon, Colorado River, Utah. Report to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Valdez, R.A. 1990. The endangered fish of Cataract Canyon. (Contract Number 6-CS-40-03980.) BIO/WEST, Inc. Report to U.S. Bureau of Reclamation, Salt Lake City, Utah.

Valdez, R.A. and G.C. Clemmer. 1982. Life history and prospects for the recovery of the humpback chub and bonytail chub. Pages 109-119 *in* Fishes of the upper Colorado River system: Present and future, W.H. Miller, H.M. Tyus, and C.A. Carlson, eds. Western Division, American Fisheries Society 182: 29-39.

Valdez, R.A., P.B. Holden, and T.B. Hardy. 1990. Habitat suitability index curves for humpback chub of the Upper Colorado River Basin. Rivers 1: 31-42.

Valdez, R.A., and R.J. Ryel. 1995. Life history and ecology of humpback chub (*Gila cypha*) in the Colorado River, Grand Canyon, Arizona. BIO/WEST, Inc. Final report (TR-250-08) to the Bureau of Reclamation, Salt Lake City, Utah.

Valdez, R.A., and R.J. Ryel. 1997. Life history and ecology of the humpback chub in the Colorado River in Grand Canyon, Arizona. Pages 3–31 *in* Proceedings of the Third Biennial Conference of Research on the Colorado Plateau, C. van Riper, III and E.T. Deshler (eds.). National Park Service Transactions and Proceedings Series 97/12.

Van Haverbeke, D.R. 2005. Stock assessment and fisheries monitoring activities in the Little Colorado River within Grand Canyon during 2004. Arizona Fishery Resource Office, Flagstaff, Arizona. 74 pp.

Ward, D.L. and S.A. Bonar. 2003. Effects of cold water on susceptibility of age-0 flannelmouth sucker predation by rainbow trout. Southwestern Naturalist 48: 43-46.

Weiss, J. 1992. The relationship between flow and backwater fish habitat of the Colorado River in Grand Canyon. Draft Report. Glen Canyon Environmental Studies, Bureau of Reclamation, Flagstaff. 13 pp.

Whitfield, M.J. 1990. Willow flycatcher reproductive response to brown-headed cowbird parasitism. Masters Thesis, California State University, Chico, California. 25 pp.

Whitfield, M.J. 1994. A brown-headed cowbird control program and monitoring for the southwestern willow flycatcher, South Fork Kern River, California, 1994. Prepared for the California Department of Fish and Game. Kern River Research Center, Weldon, CA 12 pp.

Whitfield, M.J. and C. M. Strong. 1995. A brown-headed cowbird control program and monitoring for the southwestern willow flycatcher, South Fork Kern River, California. California Department of Fish and Game, Bird and Mammal Conservation Program Report 95-4, Sacramento, California. 17 p.

Wieringa, M.J. and A.G. Morton. 1996. Hydropower, adaptive management, and biodiversity: Environmental Management 20(6): 831-840.

Willard, F.C. 1912. A week afield in southern Arizona. The Condor 14:53-63.

TABLES AND FIGURES

Table 1. Glen Canyon Dam release constraints as defined by Reclamation in the 1996 ROD (U.S. Bureau of Reclamation 1996).

Glen Canyon Dam Release Constraints		
Parameter	**Release Volume (cfs)**	**Conditions**
Maximum Flow[1]	25,000	
Minimum Flow	5,000	Nighttime
	8,000	7:00 a.m. to 7:00 p.m.
Ramp Rates		
Ascending	4,000	Per hour
Descending	1,500	Per hour
Daily Fluctuations[2]	5,000 to 8,000	

1 May be exceeded for emergency and during extreme hydrological conditions.

2 Daily fluctuation limit is 5,000 cubic feet per second (cfs) for months with release volumes less than 0.6 maf; 6,000 cfs for monthly release volumes of 0.6 maf to 0.8 maf; and 8,000 cfs for monthly volumes over 0.8 maf.

Table 2. Proposed action; elevations of Lake Powell at or above which equalization would take place.

Lake Powell Equalization Elevations	
Year	**Reservoir Elevation (feet msl)**
2008	3,636
2009	3,639
2010	3,642
2011	3,643
2012	3,645
2013	3,646
2014	3,648
2015	3,649
2016	3,651
2017	3,652
2018	3,654
2019	3,655
2020	3,657
2021	3,659
2022	3,660
2023	3,662
2024	3,663
2025	3,664
2026	3,666

Table 3. Proposed action; water storage amounts allowed per state under the storage and delivery mechanism (ICS).

Proposed Action Alternative Volume Limitations of Storage and Delivery Mechanism			
Entity	**Maximum Annual Storage of Conserved System or Non-system Water (kaf)**	**Maximum Total Storage of Conserved System or Non-system Water (kaf)**	**Maximum Annual Delivery of Conserved System or Non-system Water (kaf)**
Arizona	100	300	300
California	400	1,500	400
Nevada	125	300	300
Total[1]	**625**	**2,100**	**1,000**
Additional Amounts	625	2,100	1,000
Total[2]	**1,250**	**4,200**	**2,000**

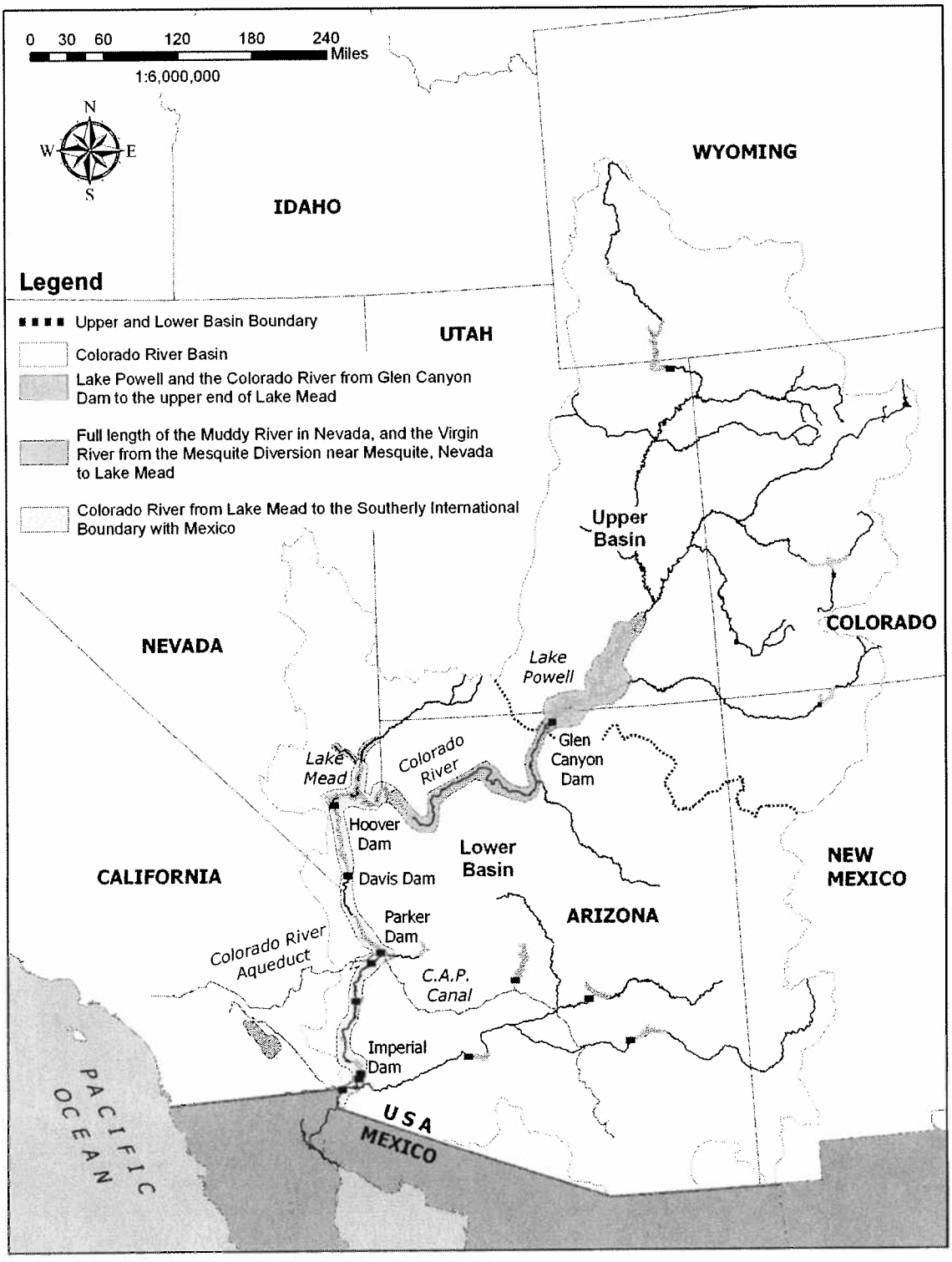
1 It is anticipated that the ICS mechanism will be implemented to allow a maximum cumulative amount of ICS credits that would be available at any one time of up to 2.1 maf.

2 The maximum cumulative amount of ICS credits that would be available at any one time is anticipated to be up to 4.2 maf.

Table 4. Relationship of Glen Canyon Dam annual release volumes to sediment transport downstream; sediment export is represented as a normalized coefficient.

Glen Canyon Dam Annual Release Volume and Normalized Sediment Transport	
Release (maf)	**Normalized Sand Export**
6.00	0.26
7.00	0.51
8.00	0.89
8.23	1.00
9.00	1.43
10.00	2.15
11.00	3.03
12.00	4.11
13.00	5.43
14.00	7.01
15.00	8.88
16.00	11.02
17.00	13.53
18.00	16.67
19.00	19.72
20.00	23.40

Figure 1. Guidelines project area.



APPENDIX A: CONCURRENCES

Concurrence for the Adoption and Implementation of the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

FWS File No. 22410-2006-F-0224

Proposed Project

This appendix contains background information and the FWS concurrence with the determinations made for Reclamation's adoption and implementation of the Guidelines. The proposed Federal action is described in the Proposed Action section of the attached biological opinion. Reclamation determined that the proposed action may affect, but is not likely to adversely affect the razorback sucker, Colorado pikeminnow, and bonytail. In addition, it was determined that there would not be adverse effects to designated critical habitat for the razorback sucker and Colorado pikeminnow. A separate set of concurrences for the interrelated and interdependent action, SNWA's Virgin and Muddy rivers tributary conservation intentionally created surplus project, are also provided below.

RAZORBACK SUCKER AND ITS CRITICAL HABITAT

Status in the Action Area

The razorback sucker was listed as an endangered species October 23, 1991 (FR 56 54957; FWS 1991). The Razorback Sucker Recovery Plan was released in 1998 (FWS 1998). The Recovery Plan was updated with the Razorback Sucker Recovery Goals in 2002 (FWS 2002c).

Critical habitat was designated in 15 river reaches in the historical range of the razorback sucker on March 21, 1994 (FR 59 13375; FWS 1994). Critical habitat includes portions of the Colorado, Duchesne, Green, Gunnison, San Juan, White, and Yampa rivers in the Upper Colorado River Basin, and the Colorado, Gila, Salt, and Verde rivers in the Lower Colorado River Basin.

Razorback sucker occur throughout the action area, from the upper reaches of Lake Powell to the upper reaches of Lake Mead, but are very rare. In Lake Powell, small numbers of razorback sucker have primarily been found in the San Juan and Colorado River inflow areas, and are likely transient fish that wash down from populations in upstream areas of those systems (Platania et al. 1991). Razorback sucker are stocked in the San Juan River as part of the San Juan River Basin Recovery Implementation Program. Despite the fact that the species can persist in reservoirs (Minckley 1991, Albrecht et al. 2007), there does not appear to be a self-sustaining population in Lake Powell. Razorback sucker have not been found in Grand Canyon (from Glen Canyon Dam to upper Lake Mead) since the early 1990s (Gloss et al. 2005), although a small, but reproducing population occurs in nearby Lake

Mead, primarily in Las Vegas Bay, Echo Bay, and the Virgin and Muddy river inflow areas (Albrecht et al. 2007). Critical habitat in the action area is present from the Paria River confluence to Hoover Dam (FWS 1994).

Razorback sucker appear to use all riverine habitats available at some point in their lives in riverine reaches where they still occur, like the Green River, but habitat studies suggest that they may avoid whitewater reaches, and historically may have been uncommon in the turbulent canyon reaches of the Colorado River such as Grand Canyon. More typically, razorback sucker are found in calm, flatwater river reaches (Lanigan and Tyus 1989, Bestgen 1990).

Reclamation has committed to investigating the potential to improve the status of razorback sucker in the action area, in collaboration with the AMP, MSCP, NPS, GCMRC and other collaborators. As part of their proposed action, Reclamation will fund the investigation and subsequent potential augmentation of the razorback sucker population in lower Grand Canyon. If augmentation is deemed appropriate, the source of augmented fish and the spatial extent of augmentation will be coordinated with FWS. Augmentation of razorback sucker in the lower Grand Canyon area, if suitable habitat exists, could result in an expansion of the range of the species and an improvement in its status.

Analysis of Effects

A primary threat to razorback sucker is predation and competition from nonnative fishes. When Lake Powell is below elevation 3,660 feet msl, a waterfall exists at the San Juan River inflow at RM 0.6, which creates a barrier to the upstream movement of nonnative fish into the San Juan River from Lake Powell. Because the proposed action could result in a greater probability that Lake Powell elevations could be low enough to form this barrier compared to current conditions, there could be a minimal potential benefit to razorback sucker in the San Juan River upstream of Lake Powell, although the waterfall would also prevent razorback sucker from moving back up into the San Juan River; we anticipate that either effect to the species is negligible.

The proposed action could affect sediment transport, water temperature, and the potential range of hourly flows in designated critical habitat present from Glen Canyon Dam to Lake Mead. The proposed action will generally result in a warmer, more variable river, which could result in increases in nonnative fishes and expansion of Asian tapeworm. Also, increases in sediment transport form the proposed action could result in fewer habitats formed by fine sediment, such as backwaters. Overall, effects to razorback sucker could be beneficial via the potential for increased survival and growth from warmer water temperatures, but also could be adverse from increased predation and parasitism, and habitat loss. However, because the species is very rare or absent in much of the action area, the probability of an adverse effect is extremely unlikely.

Conclusions

After reviewing the status of the razorback sucker including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action may affect, but is not likely to adversely affect the razorback sucker or its critical habitat, based upon the following:

- The species is extremely rare in the action area, and ongoing monitoring should detect any changes in occurrence;
- Reclamation's conservation measures for humpback chub will also serve to minimize the adverse effects of the action to razorback sucker by controlling nonnative species and parasites, which will improve this PCE of its critical habitat;
- Reclamation will, as a conservation measure, undertake an effort to examine the potential of habitat in the lower Grand Canyon for the species, and institute an augmentation program in collaboration with FWS, if appropriate.

COLORADO PIKEMINNOW AND ITS CRITICAL HABITAT

Status in the Action Area

The Colorado pikeminnow was included on the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001) and was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa), and later included under the Act as an endangered species. Critical habitat for the pikeminnow was designated on March 21, 1994 (59 FR 13374; FWS 1994). The Colorado Pikeminnow Recovery Goals, a supplement to the recovery plan, were published in 2002 (FWS 2002d).

The Colorado pikeminnow occurs in both the Colorado River downstream to Lake Powell (USFWS 2006), and in the San Juan River where they are actively stocked as part of the San Juan River Basin Recovery Implementation Program (Pfeifer et al. 2002). A few individuals are also present in Lake Powell (Platania et al. 1991), which are likely washed downstream from populations upstream. Critical habitat includes the Dirty Devil arm and the San Juan arm of Lake Powell in the action area (FWS 1994). Nonnative fish control efforts in the lower San Juan River in 2005 and 2006 captured 287 and 256 juvenile pikeminnows, respectively (Jackson 2006, Elverud and Jackson 2007). From 2002 through 2005 (Golden et al. 2006), 22 young pikeminnows were collected between Clay Crossing and Lake Powell from November 2004 to November 2005. These data indicate that Colorado pikeminnow are present in the San Juan River inflow area in low numbers; however, the area is considered to provide minimal habitat for species. Colorado pikeminnow are extirpated from the Colorado River below Glen Canyon Dam.

Analysis of Effects

A primary threat to Colorado pikeminnow is predation and competition form nonnative fishes. When Lake Powell is below elevation 3,660 feet msl, a waterfall exists at the San

Juan River inflow at RM 0.6, which creates a barrier to the upstream movement of nonnative fish into the San Juan River from Lake Powell. Because the proposed action could result in a greater probability that Lake Powell elevations could low enough to form this barrier compared to current conditions, there could be a minimal potential benefit to Colorado pikeminnow in the San Juan River upstream of Lake Powell, although the waterfall would also prevent Colorado pikeminnow from moving back up into the San Juan River. Colorado pikeminnow have been detected in Lake Powell below the barrier in low numbers (Jackson 2006, Elverud and Jackson 2007), thus the barrier could also prevent upstream movement of Colorado pikeminnow, though we anticipate that the effect of this to the species is negligible.

Conclusions

After reviewing the status of the Colorado pikeminnow including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action may affect, but is not likely to adversely affect the Colorado pikeminnow or its critical habitat, based upon the following:

- The species is very rare in the action area;
- Recovery efforts for the species are focused on upstream riverine reaches;
- The barrier that forms on the San Juan River at low reservoir elevations is not expected to adversely affect the species due to its rarity in this part of the range.

BONYTAIL

Status in the Action Area

The bonytail was listed as an endangered species on May 23, 1980 (FR 45 27710; FWS 1980). Critical habitat for the bonytail was designated on April 20, 1994, and includes portions of the Colorado, Green, and Yampa rivers in Colorado and Utah, and portions of the Colorado River in Arizona (FWS 1994). The bonytail Recovery Plan (FWS 1990) was updated and supplemented by the bonytail Recovery Goals in 2002 (FWS 2002e).

Bonytail are extremely rare in the action area from the upper reaches of Lake Powell to the upper reaches of Lake Mead. A few individuals may be present in Lake Powell. The last bonytail to be captured in Lake Powell during annual gillnet surveys (1972 through 2006) was in 1972 when a single adult was found (Utah Division of Wildlife Resources 2007); bonytail disappeared from Lake Mead in mid-1960s (U.S. Fish and Wildlife Service 1980). Due to the small numbers that appear to be present in Lake Powell and in the Colorado River upstream of the lake, the probability of any being present in the Colorado River inflow to Lake Powell is very low, and almost nonexistent below Glen Canyon Dam.

Analysis of Effects

Bonytail can occur at the Colorado River inflow area of Lake Powell, but are considered very rare here, and are likely extirpated from the Colorado River below Glen Canyon Dam to Lake Mead. Changes in Lake Powell reservoir elevations due to the proposed action will not

measurably alter habitat for bonytail in the action area. There is no bonytail critical habitat in the action area, thus none will be affected.

Conclusions

After reviewing the status of the bonytail including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action may affect, but is not likely to adversely affect the bonytail, based upon the following:

- The species is extremely rare in the action area;
- Bonytail habitat will not be measurably altered by the proposed action.

Concurrence for Southern Nevada Water Authority's Virgin and Muddy Rivers Tributary Conservation Intentionally Created Surplus Project

FWS File No. 84320-2008-I-0027

Proposed Project

The proposed Federal action analyzed in the attached biological opinion is the adoption and implementation of interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. One of the components of the proposed Federal action is the adoption of guidelines for creating and delivering conserved Colorado River system and non-system water in Lake Mead (ICS) as described in the biological opinion.

Additional information and details regarding SNWA's proposed project are available in Attachment B to the Biological Assessment (U.S. Bureau of Reclamation 2007c) and is incorporated by reference into this Appendix. SNWA currently owns approximately 3,700 acre feet per year (afy) of surface water rights on the Virgin River. On the Muddy River, SNWA owns shares in the Moapa Valley Irrigation Company representing approximately 7,000 afy of surface water rights and leases about 1,000 afy. SNWA anticipates acquiring about 30,000 afy of additional pre-BCPA water rights from entities with rights on the Virgin and Muddy rivers, with about one-third from the Virgin River and two-thirds from the Muddy River (see Table 1 in Attachment B, U.S. Bureau of Reclamation 2007c).

The Virgin River occupies a 6,000 square mile watershed situated between the Colorado Plateau, the Great Basin, and the Mojave Desert within the states of Utah, Arizona and Nevada. The Virgin River is a tributary to the Colorado River, with its headwaters in Washington County, Utah and its final discharge into the Colorado River at Lake Mead in Clark County, Nevada. Flows supporting the Virgin River are primarily provided by snowmelt in the mountains of southwestern Utah and rainfall events, with a few springs located throughout the system. In contrast, the Muddy River is primarily fed by spring discharges in the Warm Springs area of Moapa Valley, Nevada. Some rainfall events also feed flows in the Muddy River primarily from the Pahranagat Wash and Meadow Valley Wash. The Muddy River discharges into the Colorado River at Lake Mead. Prior to

construction of Hoover Dam, the Muddy River discharged into the Virgin River upstream of the Virgin River and Colorado River confluence.

A separate assessment of the potential effects of SNWA's proposed project to listed, proposed, and candidate species was included as Attachment B to the biological assessment (U.S. Bureau of Reclamation 2007c). It was determined that the proposed action may affect, but is not likely to adversely affect the southwestern willow flycatcher, Yuma clapper rail, Virgin River chub, woundfin, and the candidate western yellow-billed cuckoo, as well as no effect to the Moapa dace. In addition, it was determined that there would not be adverse effects to designated critical habitat for the southwestern willow flycatcher, Virgin River chub, and woundfin.

SOUTHWESTERN WILLOW FLYCATCHER AND ITS CRITICAL HABITAT

Status in the Action Area

The status of the species rangewide is discussed in the biological opinion. In summary, within the SNWA proposed project area, southwestern willow flycatchers have been documented as breeding along the Virgin River from near the town of Mesquite downstream to Lake Mead, and at the Overton WMA and the Warm Springs Natural Area (formerly known as the Warm Springs Ranch) in riparian vegetation along the Muddy River upstream of the town of Moapa, Nevada.

Analysis of Effects

The potential effects to the southwestern willow flycatcher from SNWA's proposed Virgin and Muddy rivers tributary conservation ICS project are described in Attachment B to the biological assessment. The proposed action could have minor beneficial effects through maintenance of tributary conservation flows in the irrigation ditches that support existing nesting and foraging habitat for the species, including critical habitat, especially nesting habitat located at existing agricultural returns. In addition, nesting or foraging habitat for the species may be enhanced or newly developed through any increase in tributary conservation flows that may remain in the main channel of the Virgin and Muddy rivers. These beneficial effects are difficult to measure in terms of direct benefit of the tributary conservation flows versus other river flows to the species and its habitat; thus, these beneficial effects are considered negligible and are not likely to adversely affect southwestern willow flycatchers.

SNWA has agreed to work cooperatively with the FWS as part of the implementation of the proposed action to provide for improved conditions for flycatchers, where possible and in coordination with necessary operations for existing irrigation companies, which can contribute to the recovery of the Virgin River listed species. This includes the commitment to explore various options and implementing any feasible options to maintain water in the main channel of the Virgin River. Exploring or implementing any such options will be in coordination with the FWS, and other entities if appropriate, and will be conducted only if such options and associated activities are in compliance with applicable Federal laws and the laws of the State of Nevada, and within SNWA's authorities and resources approved by its governing Board.

Conclusions

As described in the biological opinion, we concur that the southwestern willow flycatcher or its critical habitat is not likely to be adversely affected in the Virgin and Muddy river portions of its range, based on the following:

- The proposed action is expected to have negligible beneficial effects;
- SNWA has committed to working with FWS to explore mechanisms for retaining water in the Virgin River channel for flycatcher conservation.

YUMA CLAPPER RAIL AND ITS CRITICAL HABITAT

Status in the Action Area

The Yuma clapper rail was listed under the Endangered Species Preservation Act of 1966 on March 11, 1967 (32 FR 4001). Only populations located in the United States were listed as endangered; those in Mexico were not listed under the 1966 law or the subsequent Act. Critical habitat has not been designated for the species. The Yuma Clapper Rail Recovery Plan was issued in 1983 (FWS 1983).

The Yuma clapper rail has been documented in the SNWA proposed project area along the Virgin and Muddy rivers in marsh habitat dominated by cattail and bulrush (Braden et al. 2006, McLeod et al. 2007). This marsh habitat occupied by the species is in bands or patches located along the main channels of the Virgin and Muddy rivers. Based on surveys for the species conducted since 1997 in conjunction with southwestern willow flycatcher surveys, Yuma clapper rails have been documented along the Virgin River near the City of Mesquite, at Mormon Mesa near Halfway Wash, and the Virgin River delta (Braden et al. 2006, McLeod et al. 2007). The Yuma clapper rail has also been located along the Muddy River at the Overton WMA and in an irrigation ditch off the Muddy River (Braden et al. 2006).

Analysis of Effects

Since the majority of marsh habitat occupied by the Yuma clapper rail along the Virgin and Muddy rivers is maintained by flows in the main channel, not agricultural return flows, SNWA's proposed project is not likely to affect the species. There may be minor beneficial effects realized if habitat is enhanced or newly developed by any increase in tributary conservation flows that may remain in the main channel of the Virgin and Muddy rivers. These beneficial effects are difficult to measure in terms of direct benefit of the tributary conservation flows versus other river flows to the species and its habitat; thus, these beneficial effects are considered negligible and not likely to result in any adverse affects.

Conclusions

After reviewing the status of the Yuma clapper rail including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action

may affect, but is not likely to adversely affect the Yuma clapper rail or its critical habitat, based upon the following:

- The proposed action is unlikely to affect the Yuma clapper rail because the majority of marsh habitat along the Virgin and Muddy Rivers is maintained by flows in the main channel, not agricultural return flows;
- The proposed action is expected to have negligible beneficial effects;
- SNWA has committed to working with FWS to retain water in the Virgin River channel for flycatcher conservation.

VIRGIN RIVER CHUB AND ITS CRITICAL HABITAT

Status in the Action Area

The Virgin River chub was listed as endangered on August 24, 1989 in the Virgin River (54 FR 35305; FWS 1989). The Muddy River population of the Virgin River chub was not listed. Critical habitat was designated for this species on January 25, 2000 (65 FR 4140; FWS 2000) and a Recovery Plan was completed in April 1995 (FWS 1995c). The area designated as critical habitat for the Virgin River chub is approximately 87.5 miles of the mainstem Virgin River and its 100-yr floodplain, extending from the confluence of LaVerkin Creek to Halfway Wash.

Virgin River chub have been rare in the lowest portions of the Virgin River (Mesquite and Riverside reaches) in most years, likely because fisheries habitat in the Virgin River downstream of Beaver Dam Wash is of low quality for the species, consisting mostly of run habitat. From 2000 to 2004, no Virgin River chub were captured in either the Riverside reach or Mesquite reach (Golden and Holden 2003, 2004). The Mesquite and Riverside monitoring stations are within the SNWA proposed project area. In other years such as 2000, 2001 and 2006, Virgin River chub (typically less than 25) have been detected between the Mesquite diversion in Arizona just upstream of the Arizona/Nevada state line and the Bunkerville diversion in Nevada (all within the SNWA proposed project area).

Designated critical habitat for the Virgin River chub exists in the SNWA proposed project area as the main channel of the Virgin River and its 100-year floodplain from the Mesquite Diversion near the Arizona/Nevada state line downstream to Halfway Wash (FWS 2000). As noted in the status of the species, the number of Virgin River chub in the SNWA proposed project area is limited. The primary constituent elements for critical habitat for the species are available in the SNWA proposed project area, but are limited in quality due to modifications (e.g., infrastructure and other development, tamarisk stands, irrigation diversions, etc.) to the natural Virgin River system and its floodplain in the SNWA proposed project area.

Analysis of Effects

Potential adverse effects could occur if higher flows from the tributary conservation in concert with change in operation of the existing Bunkerville Diversion would allow for

additional nonnative species (e.g., tilapia species) to move upstream. It is foreseeable that the Bunkerville Diversion will continue to function and flows will continue to be diverted into the Bunkerville Irrigation Company system in the immediate future until a new nonnative fish barrier is constructed downstream. Thus, this potential effect is negligible.

Beneficial effects could be realized if a portion of tributary conservation flows are not diverted and remain in the main channel of the Virgin River, especially in the summer months when low water levels and high temperatures in the main channel of the Virgin River provide the most stressful conditions for the Virgin River chub. Reduced flows have long been deemed one of the most likely limiting factors for the native fish community of the lower Virgin River (Holden et al. 2001, Golden and Holden 2002, 2004). Albrecht et al. (2007b) maintained that low summer flows may be the most important factor limiting native fish populations at Beaver Dam Wash.

SNWA has agreed to work cooperatively with us as part of the implementation of the proposed action to provide for improved conditions, where possible and in coordination with necessary operations for existing irrigation companies, which can contribute to the recovery of the Virgin River listed species. This includes the commitment to explore various options and implementing any feasible options to maintain water in the main channel of the Virgin River, in coordination with the FWS, and other entities if appropriate.

Similarly, SNWA's proposed project could result in some adverse effects to designated critical habitat for the Virgin River chub, but these effects are extremely unlikely to occur. Overall, minor beneficial effects to the primary constituent elements that support critical habitat for the species in the SNWA proposed project area along the Virgin River are expected to occur. The beneficial effects could be realized if a portion of tributary conservation flows are not diverted and remain in the main channel of the Virgin River, especially in the summer months when low water levels and high temperatures in the main channel of the Virgin River provide the most stressful conditions for the Virgin River chub. Assured flows during the summer months or other dry periods would improve the quality of existing primary constituent elements for the species in the Virgin River.

Because beneficial effects of the proposed action on Virgin River chub are difficult to measure, in terms of direct contribution of the tributary conservation flows versus the contribution of other river flows to the species, any potential beneficial effects are considered negligible and no adverse affects to the species or critical habitat for the Virgin River chub are likely.

Conclusions

After reviewing the status of the Virgin River chub, including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action may affect, but is not likely to adversely affect the chub or its critical habitat, based upon the following:

- The proposed action is expected to have negligible beneficial effects;

- SNWA has committed to working with FWS to explore mechanisms for retaining water in the Virgin River channel for Virgin River chub conservation.

WOUNDFIN AND ITS CRITICAL HABITAT

Status in the Action Area

The woundfin was listed as endangered on October 13, 1970 (35 FR 16047; FWS 1970), and subsequently included under the Act. Critical habitat was designated for this species on January 25, 2000 (65 FR 4140; FWS 2000), and a Recovery Plan was completed in April 1995 (FWS 1995c). The area designated as critical habitat for the woundfin is approximately 87.5 miles of the mainstem Virgin River and its 100-yr floodplain, extending from the confluence of La Verkin Creek to Halfway Wash.

Woundfin numbers in Nevada over the monitoring period are largely a result of stocking efforts in Arizona and Nevada since the late 1990s. About 11,200 woundfin were stocked in the Nevada portion of the Virgin River in 1999; 4,500 woundfin stocked in the Nevada portion of the Virgin River in 2000 (Holden and Golden 2000, Nevada Department of Wildlife 2001); and approximately 5,000 stocked in 2003 in the Beaver Dam reach of the Virgin River. Golden and Holden (2004) sampled these areas from 1996 – 2002 and reported dramatic declines of woundfin and other native species during the drought years of 1999 through 2002. In Nevada, no woundfin were collected by the fall of 2001 and none were collected in 2002, the lowest flow year on record. Albrecht et al. (2007) report that woundfin have remained absent in this lowest portion of the Virgin River since that time. Designated critical habitat in the SNWA proposed project area is a portion of the 18.6 miles designated on the Virgin River in Nevada (total critical habitat is 87.5 miles in Utah, Arizona and Nevada).

Analysis of Effects

Potential adverse effects could occur if higher flows from the tributary conservation in concert with a change in operation of the existing Bunkerville Diversion would allow for additional nonnative species (e.g., tilapia species) to move upstream. It is foreseeable that the Bunkerville Diversion will continue to function and flows will continue to be diverted into the Bunkerville Irrigation Company system in the immediate future until a new nonnative fish barrier is constructed downstream. Thus, this potential effect is negligible.

Beneficial effects could be realized if a portion of tributary conservation flows are not diverted and remain in the main channel of the Virgin River, especially in the summer months when low water levels and high temperatures in the main channel of the Virgin River provide the most stressful conditions for the woundfin. Reduced flows have long been deemed one of the most likely limiting factors for the native fish community of the lower Virgin River (Holden et al. 2001, Golden and Holden 2002, 2004). Albrecht et al. (2007) maintained that low summer flows may be the most important factor limiting native fish populations at Beaver Dam Wash.

SNWA has agreed to work cooperatively with the FWS as part of the implementation of the proposed action to provide for improved conditions, where possible and in coordination with necessary operations for existing irrigation companies, which can contribute to the recovery of the Virgin River listed species. This includes the commitment to explore various options and implementing any feasible options to maintain water in the main channel of the Virgin River, in coordination with the FWS, and other entities if appropriate.

Similarly, SNWA's proposed project could result in some adverse effects to designated critical habitat for the woundfin, although this is extremely unlikely to occur. Overall, minor beneficial effects to the primary constituent elements that support critical habitat for the species in the SNWA proposed project area along the Virgin River are expected. The beneficial effects could be realized if a portion of tributary conservation flows are not diverted and remain in the main channel of the Virgin River, especially in the summer months when low water levels and high temperatures in the main channel of the Virgin River provide the most stressful conditions for the woundfin. Assured flows during the summer months or other dry periods would improve the quality of existing primary constituent elements for the species in the Virgin River.

Because beneficial effects of the proposed action on woundfin are difficult to measure, in terms of direct contribution of the tributary conservation flows versus the contribution of other river flows to the species, any potential beneficial effects are considered negligible, and no adverse affects to the species or critical habitat for the woundfin are likely.

Conclusions

After reviewing the status of the woundfin, including the environmental baseline for the action area, and the effects of the proposed action, FWS concurs that the proposed action may affect, but is not likely to adversely affect the woundfin or its critical habitat, based upon the following:

- The proposed action is expected to have negligible beneficial effects;
- SNWA has committed to working with FWS to explore mechanisms for retaining water in the Virgin River channel for woundfin conservation.

MOAPA DACE

Status in the Action Area

The Moapa dace was listed under the Endangered Species Preservation Act of 1966 on March 11, 1967 and under the subsequent Act. Critical habitat has not been designated for the Moapa dace. A final recovery plan was approved by the FWS for the species in 1996 (FWS 1996b).

The entire range of the Moapa dace is within the SNWA proposed project area; however, the species does not occur at or below the Wells Crossing Diversion structure where the first diversion of flows occurs on the Muddy River. Moapa dace surveys are conducted annually

on both public and private lands by the FWS, SNWA and Nevada Department of Wildlife. Since 1999, population counts have been as high as 1,296 in 2005, and as low as 907 in 2003 throughout the 5.6 miles of habitat in the upper Muddy River. The most recent surveys in February 2007 located 1,172 Moapa dace.

Analysis of Effects

As part of SNWA's proposed project any tributary conservation flows in the Warm Springs area along the Muddy River, from both existing leased water rights and potential future purchases of water rights, will remain as assured flows in the Muddy River. Therefore, no effect to the Moapa dace from SNWA's proposed project is anticipated. There is no critical habitat for Moapa dace, thus none will be affected.

Conclusions

After reviewing the status of the Moapa dace, including the environmental baseline for the action area, and the effects of the proposed action, we concur that the proposed action will not affect the Moapa dace, because the proposed action will not result in any reduction in river flows in the Muddy River.

WESTERN YELLOW-BILLED CUCKOO

Status in the Action Area

In 2001, the western yellow-billed cuckoo was designated as a candidate species for listing under the Act (66 FR 38611; FWS 2001). Candidate species receive no legal protection under the Act.

The only known nesting sites in Nevada for the western yellow-billed cuckoo are at Warm Springs Ranch Natural Area along the Muddy River in Moapa Valley (Nevada Department of Wildlife 2007). In the SNWA proposed project area, the species has been documented in the lower Virgin River near the City of Mesquite, at Mormon Mesa near Halfway Wash and at the Virgin River delta, as well as in the Muddy River at the Warm Springs Ranch Natural Area and the Overton Wildlife Management Area (Braden et al. 2006, Nevada Department of Wildlife 2007).

Analysis of Effects

Consultation is not required for candidate species; however, consideration of effects to this species from the SNWA proposed project is appreciated. The proposed action will have minor beneficial effects to the species and riparian habitat that support the species along the Virgin and Muddy rivers. The beneficial effects will be realized through maintenance of tributary conservation flows in the irrigation ditches that supports existing habitat for the species, especially nesting habitat located at existing agricultural returns. In addition, nesting or foraging habitat for the species may be enhanced or newly developed through any increase in tributary conservation flows that may remain in the main channel of the Virgin and Muddy

rivers. These beneficial effects are difficult to measure in terms of direct benefit of the tributary conservation flows versus other river flows to the species and its habitat; thus, these beneficial effects are considered negligible.

Conclusions

Based on the above information, we agree with the determination that SNWA's proposed project may affect, but is not likely to adversely affect the western yellow-billed cuckoo in the SNWA proposed project area along the Virgin and Muddy rivers because the proposed action will have negligible beneficial effects to the species.