Appendix R

Biological Assessment

This appendix contains the biological assessment (BA) for Reclamation's proposed Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead prepared by Reclamation as part of its compliance with the Endangered Species Act of 1973, 87 Stat. 884, as amended, 16 U.S.C. §1531 et seq.

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R.1 Introduction and Background

This document serves as the biological assessment (BA) for Reclamation's proposed Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead prepared by Reclamation as part of its compliance with the Endangered Species Act of 1973 (ESA), 87 Stat. 884, as amended, 16 U.S.C. §1531 et seq. This document is designed to facilitate compliance with Sections 7 and 9 of the ESA with respect to potential effects to listed species within the United States.

R.1.1 Proposed Federal Action

The Secretary of the United States Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes to adopt specific interim guidelines for Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead. Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to operation of Glen Canyon Dam and Hoover Dam and managing the mainstream waters of the Colorado River pursuant to applicable federal law, has prepared this Biological Assessment (BA) to determine if its proposed discretionary actions, as described in a forthcoming final environmental impact statement (Final EIS) that will be entitled *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*, may affect endangered or threatened species or destroy or adversely modify critical habitat of those species, as defined under the ESA.

Reclamation desires that this consultation, as defined under ESA §7(a)(2) and its implementing regulations, and resulting biological opinion (BO), if applicable, cover the period from the Secretary of the Interior's decision (proposed to be from December 2008 through September 2026)[1]. The proposed federal action includes the adoption and implementation of interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim 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). This proposed federal action considers four operational elements that collectively are designed to address shortages and coordinated operations for Lake Powell and Lake Mead.

[1] It should be noted that although the interim guidelines are for the period 2008 through 2026, the creation and delivery of conserved water from the Muddy and Virgin Rivers by Southern Nevada Water Authority, which is addressed as an interdependent/interrelated action in this BA, is proposed to be approved for a 50-year period.

The interim guidelines would 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, 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 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

The ESA compliance for the proposed action is comprised of three distinct segments. This approach is being used because three geographical areas of impact are involved, with varying degrees and types of impacts. These geographical areas include:

- Lake Powell and the Colorado River from Glen Canyon Dam to the upper end of Lake Mead (primarily related to operational element no. 2, coordinated reservoir operations).

- 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 no. 3, storage and delivery mechanism).

- The Colorado River from Lake Mead to the Southerly International Boundary with Mexico (related to operational element no.1, shortage guidelines; operational element no.2, coordinated reservoir operations; operational element no. 3, storage and delivery mechanism; and operational element no. 4, ISG). These operational elements 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 and are not addressed in this transmittal.

Each of the three segments of the consultation is prepared as a stand-alone analysis for ease of understanding. The specific elements of the proposed action that are considered discretionary and subject to compliance are described in detail below, after reviewing Reclamation's legal authorities.

R.1.2 Relevant Statutory Authority

In complying with ESA §7(a)(2) and its implementing regulations at 50 CFR §402.03, Reclamation is responsible for defining the extent of its discretionary authority with respect to this action. Reclamation's authority (discretionary and non-discretionary) stems from the following laws.

R.1.2.1 Law of the River

The Secretary is vested with the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. The responsibility is carried out consistent with a body of documents commonly referred to as the Law of the River. While there is no universally accepted definition of this term, the Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary.

Particularly notable among these documents are:

1) The Colorado River Compact of 1922 (Compact), which apportioned beneficial consumptive use of water between the Upper Basin and Lower Basin;

2) The Boulder Canyon Project Act of 1928 (BCPA), which authorized construction of Hoover Dam and the All-American Canal (AAC), required that water users in the Lower Basin have a contract with the Secretary, and established the responsibilities of the Secretary to direct, manage and coordinate the operation of Colorado River dams and related works in the Lower Basin;

3) The California Seven Party Water Agreement of 1931, which, through regulations adopted by the Secretary, established the relative priorities of rights among major users of Colorado River water in California;

4) The 1944 Treaty (and subsequent minutes of the IBWC) related to the quantity and quality of Colorado River water delivered to Mexico;

5) The Upper Colorado River Basin Compact of 1948, which apportioned the Upper Basin water supply among the Upper Basin states;

6) The Colorado River Storage Project Act of 1956 (CRSPA), which authorized a comprehensive water development plan for the Upper Basin that included the construction of Glen Canyon Dam and other facilities;

7) The 1963 United States Supreme Court Decision in *Arizona v. California* which confirmed that the apportionment of the Lower Basin tributaries was reserved for the exclusive use of the states in which the tributaries are located; confirmed the Lower Basin mainstream apportionments of 4.4 maf for use in California, 2.8 maf for use in Arizona and 0.3 maf for use in Nevada; provided water for Indian reservations and other federal reservations in California, Arizona and Nevada; and confirmed the

significant role of the Secretary in managing the mainstream Colorado River within the Lower Basin;

8) The 1964 United States Supreme Court Decree in *Arizona v. California* which implemented the Court's 1963 decision; the Decree was supplemented over time after its adoption and the Supreme Court entered a Consolidated Decree in 2006 which incorporates all applicable provisions of the earlier-issued Decrees;

9) The Colorado River Basin Project Act of 1968 (CRBPA), which authorized construction of a number of water development projects including the Central Arizona Project (CAP) and required the Secretary to develop the LROC and issue an AOP for mainstream reservoirs;

10) The Colorado River Basin Salinity Control Act of 1974, which authorized a number of salinity control projects and provided a framework to improve and meet salinity standards for the Colorado River in the United States and Mexico; and

11) The Grand Canyon Protection Act of 1992, which addressed the protection of resources in Grand Canyon National Park and in Glen Canyon National Recreation Area, consistent with applicable federal law.

R.1.3 Detailed Description of Discretionary Elements of the Proposed Action

The proposed action includes a coordinated operation of Lake Powell and Lake Mead that is designed to minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also provides a mechanism, called Intentionally Created Surplus (ICS), for promoting water conservation in the Lower Basin. 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 million acre-feet (maf). This amount could be increased up to 4.2 maf in future years during the interim period. The analysis of potential effects in this assessment includes this maximum ICS volume of 4.2 maf. The expansion of the ICS mechanism in the future would be based on operational experience gained during implementation of the proposed action. The formulation of the four operational elements for the proposed action follows.

R.1.3.1 Shortage Guidelines

The proposed action provides discrete levels of shortage associated with specific Lake Mead elevations as presented below. The shortages modeled under the proposed action are as follows:

- When Lake Mead is projected to be below elevation 1,075 feet msl and at or above 1,050 feet msl on January 1, a shortage of 333 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 Basin States, to discuss further measures that may be undertaken consistent with the Law of the River. [2]

The volumes of shortages are expressed as reductions to water users in the United States. However, modeling of the proposed action includes the assumption that Mexico would also incur water reductions proportional to the reductions to United States users in the Lower Basin at the same Lake Mead elevations (equivalently expressed as a water reduction to Mexico of 16.7 percent of the total shortage volume). As such, the maximum shortage volume modeled under this alternative is 600 kaf and water reductions of water deliveries are assumed to be applied to deliveries to the Lower Division states and Mexico.[3]

R.1.3.2 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.

R.1.3.2.1 Equalization

The proposed action provides an elevation schedule (Table R-1) that would be used in determining when equalization releases would be made.

When Lake Powell 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 mafy to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

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[2] The specific outcome of a consultation process to define additional shortages cannot be predicted; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be imposed at Lake Mead elevations below 1,025 feet msl.

[3] Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1994 Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande (1944 Treaty) or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the International Boundary and Water Commission in consultation with the Department of State.

Table R-1
Proposed Action
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

R.1.3.2.2 Upper Elevation Balancing

When Lake Powell is below the elevations stated in Table R-1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes 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.

R.1.3.2.3 Mid-Elevation Releases

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

R.1.3.2.4 Lower Elevation Balancing

When the projected end of water year elevation of Lake Powell 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.

R.1.3.3 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 (retirement of pre-Boulder Canyon Project Act of 1929 water rights on the Virgin and Muddy rivers). The ICS mechanism provides for creating credits for the conserved or imported water and delivering the water at a later date.

The analysis of potential effects in this assessment includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf. However, it is anticipated that the ICS mechanism will be initially implemented to allow a maximum cumulative amount of ICS credits of up to 2.1 maf.

The volumes of ICS activity that are assumed for each state and other entities (shown as "Additional Amounts") are presented in Table R-2. 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.[4]

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS mechanism would benefit the system through Lake Mead storage credits. At the time the ICS credits are created, five 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 three 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.

[4] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (4) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

Table R-2
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 analysis of potential effects in this BA includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf.*

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 R-2.

R.1.3.4 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.[5] 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.

R.1.3.5 Interdependent and Interrelated Actions

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 describes the interdependent actions associated with the proposed action.

[5] During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

R.1.3.5.1 Storage and Delivery of Conserved Water by Southern Nevada Water Authority

The Southern Nevada Water Authority (SNWA) intends to allow water in the Muddy and Virgin Rivers that was historically diverted from those rivers for beneficial 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 the creating, storage and delivery of conserved water in Lake Mead does not currently exist. Therefore, SNWA would not be able to perform this activity absent adoption of the proposed action. Therefore, the effects of routing the additional Virgin and Muddy River flows downstream to Lake Mead will be analyzed in this BA (Attachment B) as an interdependent action.

R.1.4 Geographic Scope and Extent of 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) to the high pool elevation of Lake Mead (elevation 1,229). Elevation 1,229 was used to define the full pool of Lake Mead in the MSCP BA.

- 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.

- The Colorado River and its floodplain from the high pool elevation of Lake Mead to the Southerly International Boundary (SIB) with Mexico.

This BA addresses the potential affects of the proposed action for all portions of the action area except from the high pool elevation of Lake Mead (elevation 1,229) to the SIB. The Lower Colorado River MSCP provides ESA compliance for a range of river operations from the high pool elevation of Lake Mead to the SIB and included development of shortage criteria as a covered action. Based on Reclamations review of the proposed action described in Attachment A (transmitted in a separate letter), Reclamation has concluded that the range of operations under the proposed action was fully covered under the MSCP BCO, and that no significant new information exists that would require additional consultation for the four operational elements of the proposed action within the MSCP planning area boundary. This conclusion is documented in Attachment A. Consequently, the potential effects of the proposed action on the segment of the action area from the high pool elevation of Lake Mead to the SIB is not addressed further in this BA.

Reclamation has concluded that the service areas of the CAP (and other 4th priority Arizona contractors), SNWA, and Metropolitan Water District should not be included within the action area for this BA. Section 7 analyses require the definition of an "action area" for use in describing the environmental baseline and the effects of the action (including indirect, interrelated, and interdependent effects). The action area is defined as the area likely to be affected by the direct and indirect effects of the proposed agency action (50 CFR §402.02). Regulations for implementing section 7 of ESA define indirect effects as those effects that are caused by or result from a proposed action, occur later in time than the direct effects, and are reasonably certain to occur. All of these conditions must be met to qualify as an indirect effect.

As described in the EIS for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, the proposed action is expected to have socio-economic effects in the service areas in terms of fallowing of agricultural lands and reductions in Colorado River water available to municipal users during shortages.[6] However, Reclamation does not have the authority to decide how farmers or municipal water providers will operate under Shortage conditions. For example, Reclamation does not control, and cannot anticipate which specific agricultural acreages may be planted or fallowed as a result of changes in water deliveries under the proposed action, nor are individual water district's and farm operator's responses to various water delivery conditions predictable over the long-term given access to alternative sources of water, economic conditions, and other factors. Additionally, many of the potentially affected Colorado River water users have alternative water supplies. Reclamation has no relationship or role with respect to how these entities may use these alternative water supplies.

In order to identify indirect effects on listed species, the effect must be identifiable (site-specific), caused by the proposed action, and reasonably certain to occur. Available information does not support a substantive causal connection between shortage conditions and fallowing of specific lands in the Arizona. While fallowing is likely to occur under the proposed action (and under No Action), the extent and location of such fallowing is subject to a number of factors beyond Reclamation's control as described above. Therefore, the effect on any specific parcel of land is not reasonably certain to occur as a result of the adoption of the proposed action. Accordingly, Reclamation has determined to exclude the water-use areas from the action area described in this BA.

The proposed action will not affect environmental conditions along the Muddy and Virgin Rivers, however, as described under Section 1.3.5, *Interdependent and Interrelated Actions*, SNWA's interdependent action could affect ESA-listed, proposed, and candidate species present along the Muddy and Virgin Rivers. A separate assessment of the potential effects of SNWA's action on ESA-listed, proposed, and candidate species within this portion of the action area is included in Attachment B and is summarized in this BA.

[6] It should be noted that shortage conditions also occur under the No Action Alternative. The timing, probability, and magnitude of shortages may be different under the proposed action.

Figure R-1 shows the geographic scope for the BA. The portion of the Geographic Scope from the full pool of Lake Mead to the SIB is addressed via correspondence with the FWS found in Attachment A and is not specifically addressed further in this BA. Attachment B describes the geographic scope associated with the interdependent and interrelated actions of SNWA on the Muddy and Virgin Rivers. The portion of the Geographic Scope shown on Figure 1 that is specifically analyzed further in this BA includes the full pool of Lake Powell and the Colorado River and its floodplain from Glen Canyon Dam to the full pool elevation of Lake Mead defined by elevation 1,229 feet msl.

R.1.5 Species Identified for Analysis

ESA-listed, proposed, and candidate species that are or could be present in the action area and the species that are evaluated in this BA are listed in Table R-3. Reclamation has determined that, based on information presented in the MSCP BA and BCO regarding the potential effects of similar actions, the proposed action will have no effects on the California brown pelican, California condor, and desert tortoise. The portion of the Colorado River within the action area is outside of the range of the California brown pelican, though a few individuals may infrequently stray into the study area during migration. Additionally, anticipated effects of the proposed action on aquatic habitats used by the species (i.e., reservoir and river stage elevations) are not expected to affect individuals that stray into the affected area. The California condor and desert tortoise are both associated with upland habitats that will not be affected by the proposed changes in reservoir and river operations. The bald eagle has recently been delisted and only occurs as a wintering species from Lake Powell to Lake Mead. The proposed action is not expected to affect the bald eagle because it will not affect the availability of fish or other bald eagle prey. The relict leopard frog only occur from Lake Mead to the SIB and, therefore, are covered under the MSCP BCO and are not addressed further in this BA.

Figure R-1
Geographic Scope

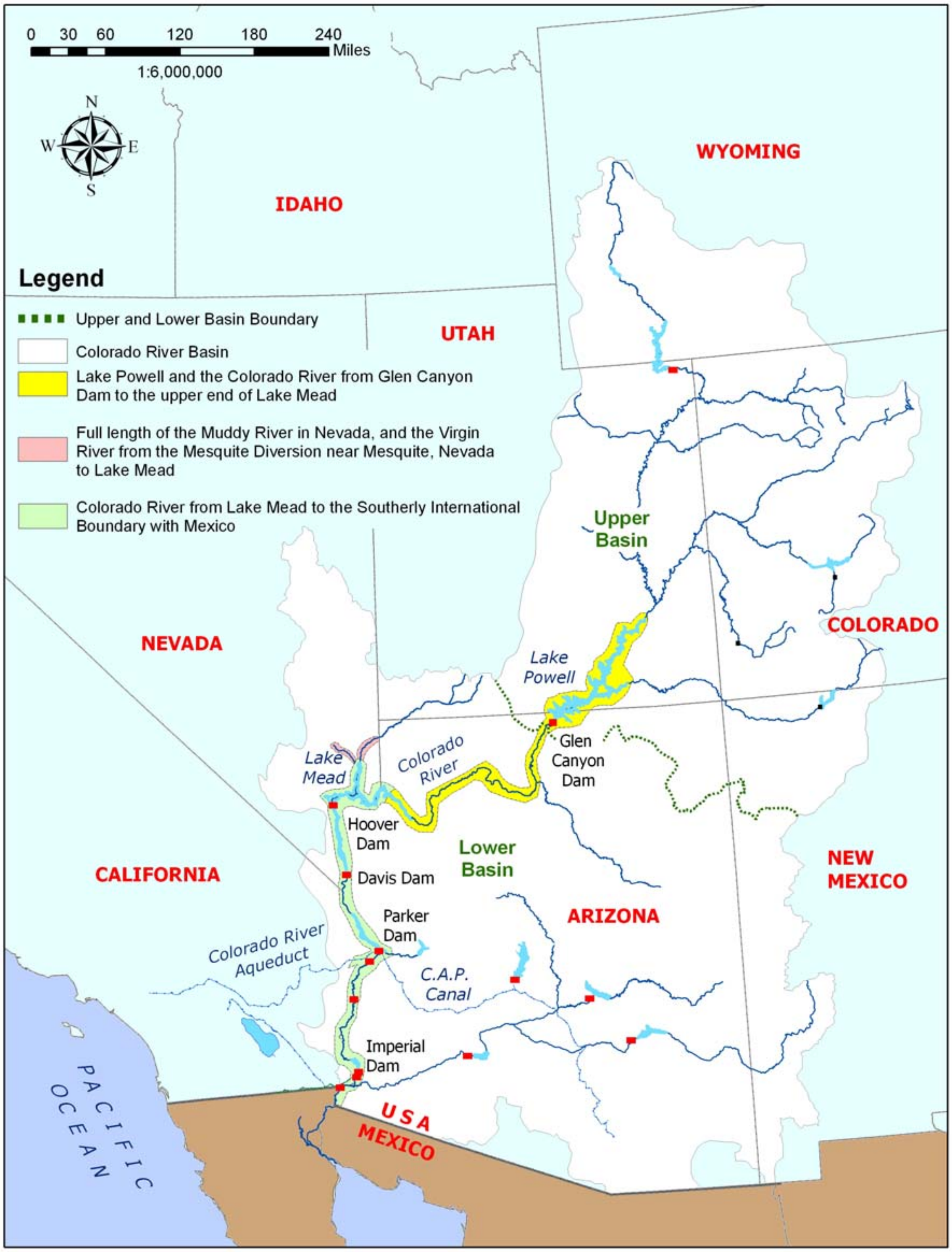


Table R-3
Species Analyzed in this Biological Assessment from Lake Powell
to the Upper End of Lake Mead, and Along the Muddy and Virgin Rivers in Nevada

Common and Scientific Name	ESA Status[1]	Designated Critical Habitat Present in the Action Area	Evaluated in this BA
California brown pelican[2] *Pelecanus occidentalis*	E	No	No
Bald eagle[3] *Haliaeetus leucocephalus*	D	No	No
Yellow-billed cuckoo[5] *Coccyzus americanus*	C	Not applicable	Yes
Southwestern willow flycatcher[4] *Empidonax trailii extimus*	E	Yes	Yes
California Condor[3] *Gymnogyps californianus*	E	No	No
Yuma clapper rail[5] *Rallus longirostris yumanensis*	E	No	Yes
Desert tortoise (Mohave population)[2] *Gopherus agassizii*	T	Yes	No
Relict leopard frog[2] *Rana onca*	C	Not applicable	No
Moapa dace[6] *Moapa coriacea*	E	No	Yes
Woundfin[6] *Plagopterus argentissimus*	E	Yes	Yes
Virgin River Chub[6] *Gila robusta seminude*	E	Yes	Yes
Bonytail [4] *Gila elegans*	E	No	Yes
Humpback chub[7] *Gila cypha*	E	Yes	Yes
Razorback sucker[4] *Xyrauchen texanus*	E	Yes	Yes
Colorado pikeminnow[4] *Ptychocheilus lucius*	E	Yes	Yes
Kanab ambersnail[4] *Oxyloma haydeni kanabensis*	E	No	Yes

1 ESA Status
E = Listed as endangered under the Federal Endangered Species Act (ESA).
T = Listed as threatened under ESA.
C = Candidate for listing under ESA.
D = Delisted.

2 Species only present from Lake Mead to the Southerly International Boundary (SIB).

3 Species present only from Lake Powell to the SIB.

4 Species present in all portions of the action area.

5 Species present from Lake Mead to the SIB, and along Muddy and Virgin Rivers.

6 Species present only along the Muddy and/or Virgin Rivers and only analyzed in Attachment B.

7 Species present from Lake Powell to Lake Mead.

R.2 Environmental Baseline

The environmental baseline for Lake Powell to Separation Canyon includes past and present impacts of all Federal, state, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 C.F.R. §402.02). In terms of past federal actions, the most important past actions that are included in the baseline are:

- Reclamation's construction and continued operation of Glen Canyon Dam and Hoover Dam;
- Reclamation's implementation of the 1996 ROD on Glen Canyon Dam and subsequent experimental actions and consultations, including the Interim Surplus Guidelines; and
- Stocking of rainbow trout, brook trout and brown trout in the Colorado River and various tributaries.

In terms of past state or tribal actions, the most important past actions in the baseline are:

- Stocking rainbow trout in the tailwater below the dam;
- Stocking sport fish (largemouth bass, crappie, smallmouth bass, striped bass) in Lakes Powell and Mead; and
- Stocking threadfin shad to provide a forage base (NPS, 1996).

R.2.1 Related Consultation History

Reclamation has consulted with the USFWS under section 7 of the ESA for various projects that could have had effects on ESA listed species and designated critical habitat within the action area from Lake Powell to Lake Mead. These consultations are included in the environmental baseline. Although the projects and their potential effects have varied, the FWS has concluded that the projects would not jeopardize the continued existence of any species or adversely modify designated critical habitat or that jeopardy and adverse modification could be avoided through reasonable and prudent alternatives (RPAs). All elements of the 1995 Biological Opinion on Glen Canyon Dam have not yet been fully implemented.. However, FWS has agreed with Reclamation that significant progress has been made on some elements of the of the 1995 biological opinion. Reclamation continues efforts to implement the 1995 biological opinion through experimentation and adaptive management in consultation with FWS. Reclamation consultations on projects relevant to the proposed action are summarized below.

R.2.1.1 Operation of Glen Canyon Dam

Reclamation received a BO from the FWS on their proposed alternative for the Operation of Glen Canyon Dam EIS in January 1995. The 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 razorback sucker and was likely to destroy or adversely modify their critical habitat, but was not likely to jeopardize the bald eagle, Kanab ambersnail and peregrine falcon. The 1995 BO on the Operation of Glen Canyon Dam identified reasonable and prudent alternatives (RPAs) that were necessary to avoid jeopardizing the continued existence of the humpback chub and razorback sucker. Elements of the RPA included the following:

- Development of an adaptive management program including: an experimental flow program, including study of seasonally adjusted steady flows; feasibility analysis of a selective withdrawal program for Glen Canyon Dam; and determination of native fish responses to various temperature and flow conditions.

- Protection of the humpback chub spawning population in the Little Colorado River by participating in development of a management plan for this river.

- Sponsor a workshop to develop a razorback sucker management plan for the Grand Canyon.

- Establishment of a second spawning aggregation of humpback chub downstream of Glen Canyon Dam.

The Operation of Glen Canyon Dam Final EIS analyzed alternative operation scenarios that met statutory responsibilities for protecting downstream resources and achieving other authorized purposes. The 1996 Glen Canyon Dam ROD describes detailed criteria and operating plans for dam operations and includes other management actions to accomplish this objective; among these are the Glen Canyon Dam Adaptive Management Program (AMP) of scientific monitoring and experimentation, beach/habitat-building flows (BHBF), and further study of temperature control.

The AMP provides a process for assessing the effects of Glen Canyon Dam operations on downstream resources and project benefits. The results of those assessments are used to develop recommendations for modifying Glen Canyon 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 include federal and state agencies, representatives of the seven Basin States, Indian tribes, hydroelectric power customers, environmental and conservation organizations, and recreational and other interest groups.

The BHBF releases are scheduled high releases of short duration that are in excess of power plant capacity in accordance with hydrologic triggering criteria. These BHBFs are designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. The first test of a BHBF was conducted in spring of 1996, and a subsequent test of a BHBF was conducted in November 2004.

Evaluating the feasibility of increasing the temperature of water released from Glen Canyon Dam was a common element in the Glen Canyon Dam EIS and one of the elements of the reasonable and prudent alternative in the 1995 Biological Opinion (BO) of that document. In 1999, Reclamation issued an environmental assessment regarding potential modification of Glen Canyon Dam to construct a selective withdrawal structure, and has subsequently continued to investigate various structural designs. The recent drought-induced drawdown of Lake Powell has resulted in warmer release temperatures, providing an opportunity to monitor the effects on habitat, reproduction and recruitment. Reclamation has initiated a NEPA process that, among other elements, will consider construction of a selective withdrawal structure as part of a long-term experimental plan. This process will include additional consultation on the long-term experimental plan, which includes a program of experimentation, building on past scientific efforts within the AMP(71 Fed. Reg. 64982-64983 and 71 Fed. Reg. 74556-74558).

R.2.1.2 Spring 1996 Beach/Habitat-Building Flow from Glen Canyon Dam

The consultation that resulted in the January 1995 BO on the preferred alternative for the Operation of Glen Canyon Dam (Section 2.4.1.2 above) was re-initiated in November of 1995 to allow for a proposed test of beach/habitat-building flow (test flow) from Glen Canyon Dam in the spring of 1996 in the Colorado River. Consultation with the FWS was re-initiated on the preferred alternative from the 1995 FEIS because a new species was listed since the original consultation (the southwestern willow flycatcher with proposed critical habitat), and new information revealed that incidental take for the Kanab ambersnail determined in the January1995 biological opinion on the Operation of Glen Canyon Dam preferred alternative would be exceeded. Reclamation concluded in its BA that the test flow would have no effect on the endangered peregrine falcon, threatened bald eagle and the endangered razorback sucker. The FWS concluded it its BO that the proposed test flow was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail and southwestern willow flycatcher, and was not likely to destroy or adversely modify humpback chub critical habitat. The FWS also provided a conference opinion that the test flow was not likely to destroy or adversely modify proposed southwestern willow flycatcher critical habitat.

R.2.1.3 November 1997 Fall Test Flow from Glen Canyon Dam

The Fall Test flow was proposed as a test of a powerplant release of 31,000 cfs for 48 hours. While powerplant capacity releases were described in the FEIS as Habitat Maintenance Flows, such a test in the fall was not addressed in the 1995 FEIS, which necessitated the re-initiation of consultation. Reclamation concluded in its BA that this proposed action would have no effect on the southwestern willow flycatcher or its critical habitat, the razorback sucker or its critical habitat, the bald eagle or the American peregrine falcon. The FWS in its BO concluded that the test flow was not likely to jeopardize the continued existence of the humpback chub or Kanab ambersnail and is not likely to destroy or adversely modify designated critical habitat for the humpback chub.

R.2.1.4 2002-2004 Proposed Experimental Releases From Glen Canyon Dam and Removal of Non-Native Fish

The 2002 biological opinion included the following actions: (1) experimental releases from Glen Canyon Dam (2) mechanical removal of non-native 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 non-native fish suppression flows having daily fluctuations of 5,000-20,000 cfs from Glen Canyon Dam during the period January 1-March 31.

Reclamation in its September 2002 BA (included within the Environmental Assessment for the proposal) concluded the action was likely to adversely affect the Kanab ambersnail, humpback chub and its critical habitat and bald eagle and was not likely to adversely affect the razorback sucker and its critical habitat, southwestern willow flycatcher and its critical habitat and California condor. The FWS concluded that the proposed action was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail and bald eagle and concurred that the proposed action was not likely to adversely affect the razorback sucker or its critical habitat, California condor and southwestern willow flycatcher. The December 2002 BO included the incidental take of up to 20 humpback chub during the non-native fish removal efforts and the loss of up to $117m^2$ of Kanab ambersnail habitat.

Two Conservation Measures included were included in the FWS BO. The first included re-location of 300 humpback chub above Atomizer Falls, an impassable barrier, in the Little Colorado River to increase the likelihood of humpback chub surviving a flood in the Little Colorado River basin, reduce predation and other inclement environmental conditions. The second conservation measure consisted of temporary removal and safeguard of approximately $29m^2$ – $47m^2$ (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.

The sediment input-triggered high experimental flow was analyzed for an indefinite period of time because of the uncertainty of knowing when the sediment trigger would be reached. The other two actions were analyzed for the period of water years 2003 and 2004. Consultation was re-initiated in 2004 to make several changes to the timing and duration of the proposed experiments described in the 2002 consultation. The 2004 high flow experiment was intended to occur in the fall, immediately following significant tributary sediment inputs, while the 2002 high flow experiment was proposed to occur in the spring. In November 2004 Reclamation reinitiated consultation and concluded that the proposed changes were likely to adversely affect the humpback chub and its critical habitat, Kanab ambersnail and bald eagle. Reclamation requested concurrence that the proposed changes to the action were not likely to adversely affect the razorback sucker and critical habitat, the California condor and southwestern willow flycatcher. In a BO dated November 2004, the FWS concurred that the project was not likely to affect razorback sucker or its critical habitat, California condor or southwestern willow flycatcher and concluded that the modified action was not likely to jeopardize the continued existence of the humpback chub, Kanab ambersnail or bald eagle. The FWS also concluded that designated humpback chub critical habitat would not be destroyed or adversely modified. The BO included several conservation measures related to humpback chub including the continuation of translocating humpback chub in the Little Colorado River, and further study and monitoring of the results and study of effects on chub from various flow conditions. Kanab ambersnail conservation measures included removal and safeguard of Kanab ambersnail habitat that would be inundated by the experimental release.

R.2.2 Regulatory Context

Glen Canyon Dam is operated in accordance with the 1996 ROD, its associated BO and subsequent experiments under the AMP. These requirements serve as the regulatory baseline for this BA between Lake Powell and Lake Mead. This reach was not addressed in the MSCP and thus no ESA coverage from the MSCP applies upstream of Lake Mead. The range of releases and operational constraints covered by the 1996 ROD is described below in Table R 4.

Table R-4
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.*

In the past, the annual volume of water released from Glen Canyon Dam has been made according to the provisions of the LROC that include a minimum objective release of 8.23 maf. The proposed action would allow Reclamation to change these operations by allowing for potential annual releases less than the minimum objective release under certain 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 1996 Glen Canyon Dam ROD, which would not be affected by the proposed federal action. The No Action alternative as described in the DEIS for the proposed action (Bureau of Reclamation, 2007) depicts how Reclamation would likely operate Glen Canyon Dam under shortage conditions without adoption of the proposed Shortage Criteria and Coordinated Operations for Lake Powell and Lake Mead. Effects to the species may occur when flow or reservoir conditions in this reach would deviate from flow, reservoir or water quality conditions that would occur under baseline conditions (the No Action alternative in the DEIS).

On September 1, 2006, Reclamation and the Center for Biological Diversity, Arizona Wildlife Federation, Living Rivers, Sierra Club – Grand Canyon Chapter and Glen Canyon Institute entered into a settlement agreement whereby Reclamation agreed to assess under NEPA and ESA the impacts of modifying current or prospective operations of Glen Canyon Dam. Reclamation initiated an analysis under NEPA of a long-term experimental plan (LTEP) related to the operation of Glen Canyon Dam (71 Fed. Reg. 64982-64983 and 71 Fed. Reg. 74556-74558) and anticipates that it will initiate consultation under ESA by May 1, 2008. The LTEP process is properly excluded from the Environmental Baseline and Cumulative Effects analysis in this BA as it has not yet undergone consultations. Reclamation is committed to perform this assessment and further study and has included completion of the LTEP as a proposed conservation measure for the above-listed fish species, which will be discussed later in this BA.

R.2.3 Description of Glen Canyon Dam Adaptive Management Program

The Glen Canyon Dam Adaptive Management Program (AMP) was established in 1997 to implement the Grand Canyon Protection Act of 1992 (GCPA), the 1995 Operation of Glen Canyon Dam Final Environmental Impact Statement (final EIS), and the 1996 Record of Decision (ROD). 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 operating criteria 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. 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.

The GCDAMP consists of the following major components:

- The Adaptive Management Work Group (AMWG) which is a Federal Advisory Committee which 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 which 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 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).

R.2.4 Status of Species and Critical Habitat

R.2.4.1 Southwestern Willow Flycatcher

Please refer to Attachment B for additional information related to the southwestern willow flycatcher along the Muddy and Virgin Rivers.

Legal Status. The southwestern willow flycatcher (SWFL) was designated by the U.S. Fish and Wildlife Service as endangered, on February 27, 1995 (USFWS 1995a). A final recovery plan was completed in August 2002 (USFWS 2002a), and the designation of critical habitat was finalized in October 2005 (USFWS 2005). Critical habitat was previously designated on July 22, 1997 (62 FR 39129), but was rescinded by court order on May 11, 2001.

Critical habitat has been designated for the southwestern willow flycatcher in the action area along a contiguous segment of the Virgin River in Utah, Arizona, and Nevada (USFWS 1995b). The segment extends for 73.8 miles from the Washington Field Diversion Impoundment in Washington County, UT, downstream through the Town of Littlefield, AZ, and ends in NV at the upstream boundary of the Overton State Wildlife Area in Clark County, NV.

Historical and Current Range. The historic breeding range of the SWFL included southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico (Unitt 1987, Browning 1993, Paxton 2000, USFWS 2002a). According to the critical habitat designation for SWFL, the current occupied geographic area crosses six southwestern states including southern California, southern Nevada, southern Utah, southern Colorado, Arizona, and New Mexico, from sea level to approximately 8000 feet above sea level. In general, flycatcher distribution occurs mainly in lower elevation riparian habitat, with a few patches distributed in relatively small isolated locations. When SWFL was listed as endangered in 1995, populations were estimated at 350 territories (USFWS 2002a). Through an increase in survey effort that number has increased to over 1000 territories (Durst et al. 2005). Arizona Game and Fish documented 883 resident flycatchers at 483 territories in 47 sites in 2005 (English et al. 2006). Nevada Department of Wildlife reported a total of 18 resident flycatchers at sites not surveyed by SWCA Environmental Consultants, and an average of 9 territories for surveys from 2001-2005. Approximately 73 territories were documented in 2005 by SWCA

Environmental Consultants along the lower Colorado River and at sites in Nevada and the lower Grand Canyon (Koronkiewicz et al. 2006).

Another important aspect to the distribution of SWFL is its migration routes and migration stopover habitats. This neotropical migrant travels between breeding areas in the United States to wintering grounds in Central and South America (USFWS 2005). Migration flyways include major river corridors and their tributaries such as the Gila River, Rio Grande and lower Colorado River basins (Yong and Finch 1997, Moore 2005, Koronkiewicz et al. 2006, English et al. 2006, USFWS 2005).

Wintering grounds for the willow flycatcher include portions of southern Mexico, Central America, and northern South America. Specific surveys have been conducted at sites in El Salvador, Costa Rica, Panama, Mexico, Ecuador, Nicaragua, and Guatemala (Phillips 1948, Koronkiewicz and Whitfield 1999, Koronkiewicz and Sogge 2000, Lynn and Whitfield 2002, Lynn et al. 2003, Nishida and Whitfield 2005). It is suspected that all subspecies may winter in similar locations. Because it is difficult to identify subspecies of willow flycatchers, specific areas where the SWFL winters are not fully known at this time.

Populations within the Action Area. Presence/absence surveys, along with life history studies, have been conducted along the LCR since 1996 (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, 2006, Koronkiewicz et al. 2004, 2006, and McLeod 2005). Approximately 100 sites have been surveyed in an area that includes the Virgin River, Pahranagat NWR, the Grand Canyon south of Separation Canyon, and throughout the LCR from Lake Mead to the Southerly International Boundary with Mexico. These surveys indicate that the main breeding populations occur along the Virgin River from north of Mesquite, NV to the Virgin River Delta with Lake Mead, at Pahranagat National Wildlife Refuge, in the Grand Canyon from Separation Canyon to the delta of Lake Mead, at Topock Marsh near Needles, CA, and on the Bill Williams National Wildlife Refuge. Flycatchers have nested along the river corridor in the Grand Canyon, particularly in salt-cedar. One to five territories of breeding southwestern willow flycatcher were observed between 1992 and 2003 in any one year between the Little Colorado River confluence and the Grand Canyon gauging station (Gloss, et al 2005). These occurrences have been in riparian vegetation between river miles 28 and 71. Between the Grand Canyon gauging station and the western boundary of Grand Canyon National Park, southwestern willow flycatchers have been detected at a several locations. Seven to twelve territories were identified between 1998 and 2001 between river miles 246 and 273. Surveys in 2002 and 2003 found no territories and surveys in 2004 found two territories (Gloss, et al 2005). Southwestern willow flycatcher breeding occurred in 2005 at river mile 274.5 and 15 southwestern willow flycatchers were detected during 2006 surveys at 13 different sample sites in the Lower Grand Canyon and Lake Mead delta (approximately river mile 251 to 286) (SWCA, 2007).

Populations of southwestern willow flycatcher along the LCR over the past 10 years are listed in Table R-5.

Table R-5
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
Population Along the Lower Colorado River from 1996-2005

Year	Total WIFL Detected*	SWFL Summer Resident/ Breeding
1996	202	34
1997	154	68
1998	302	113
1999	NA	133
2000	NA	135
2001	NA	218
2002	NA	142
2003	356	115
2004	793	193
2005	473	133

* *Total WIFL Detected = Migratory and breeding birds detected during presence/absence surveys. Migratory birds include other subspecies than just E.t. extimus and thus we can only confirm to species E. trailii. NA=not available.*

Breeding. The SWFL breeds across the lower southwestern United States from May through August. SWFL typically arrive on the breeding grounds between early May and early June. Males generally arrive first to set up territories, with females arriving a week or two later. Males are highly territorial and will defend their territory through counter singing and aggressive interaction. Flycatchers often clump together in one area of the habitat patch, which leads to an indication that this species is “semi-colonial”. Males are usually monogamous, but polygyny does occur at approximately 10-20 percent (USFWS 2002a, Pearson 2002). Genetic evidence suggests extra pair copulation exists by either mated or unmated males with females in neighboring territories (USFWS 2002a).

Territory size varies greatly, potentially due to population density, habitat quality, and nesting stage. Territory sizes have been estimated from approximately 0.1 ha to 2.3 ha (0.25-5.7 acres) (McCabe 1991), with most territories encompassing 0.2-0.5 ha (.5-1.2 ac) (Sogge 1995, USFWS 2002a). Territories of polygynous males are usually larger than those of monogamous males. Flycatchers’ home ranges are greater than their territories and can vary in size from 0.13 to 360 ha, depending on breeding status and surrounding habitat areas (Bakian and Paxton 2004, Cardinal and Paxton 2005).

Multi-year color banding studies have shown high site fidelity among after-second-year birds returning to former breeding patches (McKernan and Braden 2002, Koronkiewicz et al. 2006a). Juvenile dispersal is largely within the regional area, although long distance dispersal has occurred, with movements greater that 200 km reported (McKernan and Braden 2001b, Koronkiewicz et al. 2006). These movements and site fidelity suggest that the Virgin River/LCR population may be a sub-population of a greater meta-population (Koronkiewicz et al. 2006).

Nest building usually begins 3-7 days after pair formulation. Flycatchers nest in various tree species including Goodding's willow, coyote willow, cottonwood, saltcedar, boxelder, and other native and exotic tree species. Egg laying can start as early as late May, but is usually in early to mid June (Sogge et al. 1997a, Sogge et al. 1997b). Upon completion of egg laying, the female usually incubates the eggs for approximately 12 days, and all eggs usually hatch within 24-48 hours of one another. Nestlings fledge usually within 12-15 days (Paxton and Owen 2002). Chicks are usually present from mid-June through early August. SWFL will re-nest, either after the first nest fledges or after failure, and have been documented to have up to four nesting attempts and three clutches (Sferra et al. 1997, McKernan and Braden 2001b, Koronkiewicz et al. 2006). Adults depart from breeding territories as early as mid-August, but may stay until mid-September if nesting was late. Fledglings usually leave the breeding areas a week or two after adults (Sogge et al. 1997a).

Nest success averages from 40-50 percent through all years of study along the lower Colorado River (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, 2006, Koronkiewicz et al. 2004, 2006, and McLeod 2005) and approximately 25-70 percent over complete range of the SWFL (USFWS 2002a). Predation has been the leading cause of nest failure at many study sites throughout the range (USFWS 2002a), including along the LCR (McKernan and Braden 2001b and 2002, Koronkiewicz et al. 2004, 2006, McLeod 2005).

Parasitism by brown-headed cowbirds is another cause of nest failure. Cowbird parasitism may impact some SWFL populations enough to warrant management actions. The cowbird lays it eggs in the nest of the host species, and the host then incubates the cowbird eggs, which typically hatch prior to the hosts own young.

Abandonment and desertion, although typically low, are also causes of nest failure. Typically, causes for these are unknown, but addled or unfertilized eggs, disturbance, and in some cases brood parasitism may all contribute. Abandonment and desertion accounted for 13 percent and 9 percent respectively, for nest failures at life history study sites along the LCR and tributaries in 2005 (Koronkiewicz et al. 2006). For Arizona statewide surveys, abandonment and desertion together accounted for less than 6 percent of the nest failures.

Diet. The SWFL is an insectivore that hawks insects while in flight, gleans insects from foliage, and occasionally captures them from the ground (USFWS 2002a). Flycatchers forage from within the habitat or above the canopy, above water, or glean from trees and herbaceous cover (McCabe 1991, Sogge 2000, USFWS 2002a). The main diet of the flycatcher consists of small to medium size insects such as true bugs (order Hemiptera), wasps and bees (Hymenoptera), flies (Diptera), beetles (Coleoptera), butterflies and caterpillars (Lepidoptera), and spiders (Araneae) (Drost et al. 1998, McCabe 1991, Sogge 2000, Drost et al. 2001, DeLay et al. 2002, Durst 2004). Berries and small fruits have also been reported but are typically rare (McCabe 1991). The flycatcher can exploit a diverse array of insects depending on availability within the habitat (Drost et al. 1998, Drost et al. 2001, Drost et al. 2003, DeLay et al. 2002, Durst 2004). Diet may differ between sites and between years depending on abundance and availability of insects in and near the breeding habitat (DeLay et al. 2002, Drost et al. 2003, Durst 2004). Although there were differences in prey types consumed by the flycatcher among different habitats (e.g. native versus non-native), there is no significant differences in the abundance of insects available between habitats (Durst 2004), and there is no evidence that the physiological condition of flycatchers is lower in saltcedar habitats (Owen et al. 2005).

Habitat. The SWFL breeds in dense riparian vegetation near surface water or saturated soil, across a large elevational and geographic area (USFWS 2002a, Sogge et al. 1997a). Dominant plant species consist of large riparian trees such as Coyote willow (*Salix exigua*), Goodding willow (*Salix goodingii*), Fremont cottonwood (*Populus fremontii*), boxelder (*Acer negundo*), and non-native saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) (USFWS 2002a). SWFL typically nest in saltcedar in the Grand Canyon (Gloss et al. 2005).

Occupied sites vary in size and shape but all are relatively dense, with some open areas, and are usually associated with open or standing water. Occupied patches can be as small as 0.8 ha and as large as several hundred hectares, but are typically greater than 10 m wide. Although most of the sites are associated with open water, marshy seeps, or saturated soil where the nest tree can be in standing water, hydrologic conditions can change drastically during the breeding season and between years (Sogge et al. 1997a, Sogge and Marshall 2000, USFWS 2002a, Koronkiewicz et al. 2006). Because birds are exposed to extreme environmental conditions throughout the desert southwest, dense vegetation and moist soils at the nest may be needed to provide a more suitable microclimate for raising young by increasing humidity within the utilized site (Allison et al. 2003, Sogge and Marshall 2000, Koronkiewicz et al. 2006).

Vegetation analysis has occurred at life history sites along the LCR and its tributaries since 1996 (McKernan and Braden 2002, Koronkiewicz et al. 2006). Data gathered includes average canopy height, total canopy closure, woody ground cover, distance to nearest standing water or saturated soil, and additional foliage density measurements. Measurements have been taken at the nest, within territory, and at non-use plots. Analysis of this data is still being conducted and will be presented in a final report in 2008. Preliminary analysis suggests that, overall, flycatchers breed in a wide variety of habitats throughout the Virgin River and LCR. These areas contain relatively homogenous, contiguous stands of riparian vegetation that differ from each other both structurally and compositionally. Preliminary nest productivity, as related to vegetation type (e.g. non-native versus native), shows no significant difference (McKernan and Braden 2002), but further analysis will be conducted.

The presence of water is an important component of SWFL habitat (Sogge and Marshall 2000, USFWS 2002a). Studies indicate that SWFL nest sites are usually closer to water than non-use sites (Stoleson and Finch 2003, Paradzick 2005, Koronkiewicz et al. 2006). Nest sites are usually located within 200 m of open or standing water and usually contain soils that are higher in water content than non-use sites (McKernan and Braden 2002, Stoleson and Finch 2003, Paradzick 2005, Koronkiewicz et al. 2006). Water and/or moist soils help regulate temperature and relative humidity within the stand, produce the right conditions for insect development and survival, and are associated with creating a greater foliage density (USFWS 2002a, Paradzick 2005, Koronkiewicz et al. 2006).

Threats. Habitat alteration, as well as loss and fragmentation are considered one of the greatest threats to the SWFL (Marshall and Stoleson 2000). Riparian habitats in the Southwest are naturally patchy and subject to periodic disturbance. Factors contributing to habitat loss include water management, such as dams and reservoirs, diversions and groundwater pumping, channelization and bank stabilization, agricultural development, livestock grazing, phreatophyte control, increased recreation, and urbanization. All of these cause loss of habitat, habitat fragmentation, loss of critical water underneath stands, and human disturbance (Marshall and Stoleson 2000).

Although the SWFL now nests in saltcedar, this has some disadvantages. Saltcedar exudes salts and creates soils that are too salty for other native species to propagate, thus reducing diversity in the stand which may affect prey base for flycatchers. Deep root systems and extended production and proliferation of seeding from March through October gives saltcedar selective advantage over natives under stressed conditions such as lack of flooding, and may reduce soil moisture and standing water conditions needed for flycatcher habitat (Marshall and Stoleson 2000).

The SWFL has evolved with predation and cowbird parasitism, but increased populations of predators and cowbirds has become a major threat to some local populations. Predation is the leading cause of nest failure in many populations of SWFL (Marshall and Stoleson 2000, USFWS 2002a), including those along the LCR and its tributaries (McKernan and Braden 2002, Koronkiewicz et al. 2006). Known and suspected nest predators include snakes, predatory birds such as raptors, corvids, grackles and cowbirds, small mammals, and even ants (Marshall and Stoleson 2000).

Other threats that have not been studied as thoroughly include parasites, disease, and environmental toxins. Internal and external parasites have been recorded, but the extent of impacts has not been determined. Diseases such as West Nile Virus and Avian Flu are new threats that so far have not gotten into the SWFL population, but could have a devastating effect if they do, due to the small population size and the semi-colonial aspect of the SWFL. Environmental toxins may also play a factor as populations close to agriculture and human habitats, such as golf courses, increase the possibility of toxins entering into the diet of the flycatcher. Although this has not been studied to any great extent, bill deformities and missing eyes have been reported from birds at sites in Arizona, Colorado, and New Mexico. A study was completed on environmental contaminants in surrogate birds and insects found in SWFL habitat in Arizona. This study showed an accumulation of inorganic elements in eggshells and contents of eggs, although the only contaminant in this study with unusually high levels was strontium (Mora 2002). Increased concentrations of this metal may be associated with decreased egg production, and potentially higher embryonic mortality, but further studies are needed.

R.2.4.2 Yellow-billed cuckoo, Yuma Clapper Rail, Moapa Dace, Woundfin, Virgin River Chub

Please refer to Attachment B for information related to the yellow-billed cuckoo, Yuma clapper rail, Moapa dace, woundfin and Virgin River chub along the Muddy and Virgin Rivers since these species do not occur in the action area from Lake Powell to Lake Mead.

R.2.4.3 Bonytail Chub

Legal Status. The bonytail was federally listed as endangered under the Endangered Species Act in 1980. No critical habitat is designated in the action area.

Historical and Current Range. Bonytail was historically widespread and common throughout tributaries of the Colorado River and other larger rivers, with historical captures documented from Mexico to Wyoming (Behnke and Benson 1980, Minckley and Deacon 1991, Mueller and Marsh 2002). The first recorded capture of bonytail from the Upper Colorado River Basin (UCRB) was by Jordan (1891) with one specimen collected from the Green River. Subsequent historical collections, albeit limited largely to anecdotal and historical fishing creel interviews, in conjunction with limited scientific collection information combine to demonstrate the once-expansive range of bonytail (USFWS 2002b). However, during the 1950s bonytail populations began a rather large, yet poorly documented decline in abundance following numerous biotic and abiotic habitat modifications. Holden (1991) described the effects of a large-scale rotenone treatment in the upper Green River, while simultaneously providing insight to the rather large population of bonytail present until 1962, at which time a large piscicide treatment occurred in the UCRB. Bonytail numbers were drastically reduced following the closure of Flaming Gorge Dam in 1963, with very few and sporadic captures of bonytail occurring in the UCRB since that time (Vanicek and Kramer 1969, Holden and Stalnaker 1975, Tyus et al. 1982, Valdez 1990).

Bonytail captures along the Lower Colorado River (LCR) follow similar trends. The USFWS (2002b) documents an early capture of 16 individuals from the LCR by R.R. Miller (from the Grand Canyon). Jonez and Sumner (1954) documented a large aggregation of an estimated 500 adults spawning over a gravely shelf in Lake Mohave. During the period between 1976-1988, 34 bonytail were captured in Lake Mohave, and some of these fish were incorporated in the establishment of a brood stock, the progeny of which are presently stocked into Lakes Mohave and Havasu (Minckley et al. 1989, Minckley et al. 1991, USFWS 2002b) and a number of UCRB rivers. Very few documentations of wild bonytail capture have been recorded in recent years and, therefore, little is known about the specific habitat requirements of this unique species. Bonytail are considered extirpated from the Colorado River between Glen Canyon Dam and Lake Mead, and they have a low probability of occurring at the inflow areas of Lake Powell (see below).

Populations within the Action Area. Populations of bonytail in the action area are limited primarily to those within Lake Mohave and Lake Havasu, and these populations are being augmented with stocking with hatchery-reared young due to lack of natural recruitment (Moyle 2002, USFWS 2001). A self-sustaining population has been established in the Cibola High Levee Pond that is not connected to the Colorado River. A few individuals may also be present in Lake Powell (USBR 2000). Small populations may still be present in the Upper Colorado River Basin in the Yampa River, Green River, and Colorado River at the Utah/Colorado border (USBR 2000, USFWS 2006). 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 DWR, 2007). 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.

Reproduction. Vanicek and Kramer (1969) documented the last substantial spawning of a wild, riverine population of bonytail in Dinosaur National Monument. Ripe fish were collected from mid June through early July in water temperatures around 18ºC. Bonytail estimated between 5-7 years old were found ripe (Vanicek 1967), whereas in controlled hatchery environments, Hamman (1985) found bonytail to begin maturing sexually at age 2. Johnston (1999) classified bonytail as being broadcast spawners and suggested that loss of eddy habitat types due to the construction of impoundments may contribute to the apparent reproductive failure of a closely related species, the humpback chub. Marsh (1985) reported bonytail eggs to be adhesive and apparently remain so throughout the incubational period, which is thought to be an adaptive strategy to swift-moving currents of the mainstem Colorado River.

Ripe bonytail have also been collected from lentic, reservoir situations. As stated previously, Jonez and Sumner (1954) reported active spawning of a large (approximately 500 individuals) aggregate of bonytail in Lake Mohave. Eggs were described as being adhesive, and one individual female contained over 10,000 eggs, suggesting a high level of fecundity, a trait that appears to be typical for native, Colorado River endemics (see razorback sucker species profile). Even higher levels of fecundity were found in hatchery settings, with individual female egg production averaging over 25,000 eggs per female (Hamman 1982). Spawning bonytail in Cibola High Levee Pond were observed utilizing shoreline riprap materials, typically in mid April and frequently during nighttime hours, in water temperatures ranging from 20.4-21.6ºC. They were observed consuming their own gametes, as well as young razorback sucker larvae (Mueller et al. 2003).

Valdez (2006) summarized spawning and incubation temperatures for bonytail as 18-22ºC with an optimum of 20ºC and 18-28ºC with an optimum of 21ºC, respectively.

Bonytail egg survival appears to be highly influenced by incubation temperature. Hamman (1982) found 90 percent survival at water temperatures of 20-21ºC, 55 percent survival at 16-17ºC, and only 4 percent survival when temperatures were held between 12-13ºC. Incubation periods ranged from 99 hours to nearly 500 hours, depending upon water temperatures. Newly hatched fry averaged 6.8 mm (Hamman 1982). This research is corroborated by Marsh (1985), who found bonytail embryos to have the highest survival rates at temperatures near 20ºC and indicated that newly hatched larvae averaged 6.0-6.3 mm in size.

Diet. Bonytail diet is reportedly comprised of a wide variety of aquatic and terrestrial insects, worms, algae, plankton, and plant debris (Mueller and Marsh 2002). This information is corroborated by McDonald and Dotson (1960) and Vanicek (1967) who also found Colorado River chub to feed omnivorously. More detailed and quantitative descriptions of bonytail diet preferences are not available, including shifts in diet composition by life stage, with the exception of information from bonytail stocked into Cibola High Levee Pond. This experimental population also fed omnivorously, with adult bonytail consuming algae, vegetative material, small fish, and crayfish (Procambarus and *Orcopectes* sp.). Young bonytail were documented to feed near the surface of the pond, with gut analysis demonstrating that smaller size classes typically fed on zooplankton and invertebrates (Mueller et al. 2003). Again, more detailed knowledge is unavailable, likely due to the overall rarity of the species.

Habitat. As stated previously, information pertaining to bonytail habitat preferences is very limited due to the extirpation of this species prior to extensive sampling of the Colorado River and its fishery. Limited, early fisheries surveys indicate that the bonytail tended to be found in higher-gradient, gravelly riverine sections, with some degree of habitat use similarities as described for the flannelmouth sucker. For example, bonytail is widely characterized as being adapted to the swifter sections of the Colorado River, with affinity for areas of high flow and rocky habitat. Available information suggests that adult bonytail used fast-water sections, as well as eddies and pool habitats. Vanicek (1967) noted habitat selection of bonytail to coincide with habitats occupied by another native chub, the roundtail chub. Vanicek (1967) found these species in pools and eddies, typically near “fast-flowing” riverine areas but also in slower sections. Holden (1991), citing Flaming Gorge preimpoundment surveys, noted that bonytail were apparently fairly common in the Flaming Gorge area of the upper Green River, a canyon-bound, relatively fast water section of river. Valdez (1990) reported bonytail habitat use as being similar to that of humpback chub, with collections being made in shoreline eddy habitats, boulders and cobble, and near swift-water sections (in Cataract and Desolation Canyons).

Telemetry studies by Mueller et al. (2003) revealed that adult bonytail prefer interstitial spaces associated with shoreline riprap during daylight hours in Cibola High Levee Pond, whereas open-water areas are more commonly utilized during the nighttime hours. Intensive telemetric surveillance suggests a high degree of site-specific habitat fidelity, with individually marked bonytail consistently returning to the same cavities formed within the riprap type shoreline. These areas may simulate the boulder fields of many of the Upper Colorado River Basin canyon areas where bonytail were once common. Interestingly, a study conducted by Pimentel and Bulkley (1983) suggests that bonytail, when given the opportunity, tend to select water with high levels of total dissolved solids (TDS). Bonytail are able to persist in water with TDS of 4,700 mg/L, the highest tolerance reported for any species of Colorado River Gila, suggesting an ability to persist despite anthropogenic water quality and habitat degradation.

Bonytail have been documented to spawn over gravel substrates, near shore, and were found in water up to 30 ft deep in reservoir situations (Jonez and Sumner 1954). They are hypothesized to use gravel-cobble habitats in lotic environments. Most recently in the Lower Colorado River Basin (LCRB), documentation of successful, natural reproduction in Cibola High Levee Pond suggests that bonytail select shoreline-associated, riprap materials (large-diameter gravel, cobble, and boulder substrates) in water 2-3 m deep for spawning activities (Mueller et al. 2003). Spawning individuals in Lake Mohave display similar diet habitat shifts: adults use in deeper habitats during the day and later form congregations along shoreline habitats (Mueller and Marsh 2002).

Relatively little is known about habitat needs for young bonytail. Similar to other native fishes, backwaters and other slackwater habitat types are thought to serve as important nursery areas for young bonytail (USFWS 2002b). Larval roundtail and humpback chub tend to use low-velocity backwaters, embayments, and other small, low-velocity habitats along shorelines, moving to water with more current as they become larger (50-75 mm) (Holden 1977, Valdez 1990, Valdez and Ryel 1997). Whether bonytail exhibit the same habitat shift is not known, but it is very likely that the primary reason for the loss of bonytail throughout the basin is related to loss of important nursery habitat. Relatively narrow nursery habitat requirements separate razorback sucker and Colorado pike minnow from the non-endangered, more common species such as flannelmouth sucker and roundtail chub. Therefore, it seems likely that in a riverine situation bonytail may have a nursery habitat requirement that has not as yet been fully explained.

Young bonytail were most commonly associated with areas of dense overhead cover in depths greater than 1 m. They displayed schooling in warm, shallow areas of Cibola High Levee Pond (Mueller et al. 2003). These findings suggest that refugia-type backwaters designed for bonytail should have similar components in terms of riprapped shoreline materials, one of the few specific habitat preferences that have been documented to date.

Threats. Numerous researchers have identified that the major factor contributing to the decline of bonytail and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, riverine environment (Holden and Stalnaker 1975, Minckley et al. 1991, Mueller and Marsh 2002, USFWS 2002b). Competition and predation from non-native fishes that are successfully established in the Colorado River and its reservoirs have also contributed to their decline (Minckley and Deacon 1991, USFWS 2002b). For further detailed information including examples, ramifications, and research needs pertaining of the effects of habitat modifications on native Colorado River fishes, please see Tyus (1982), Minckley and Deacon (1991), Mueller and Marsh (2002), and USFWS (2002b).

R.2.4.4 Humpback chub

Legal Status. Humpback chub is listed as endangered under the ESA. Critical habitat has been designated in the Colorado River from Nautiloid Canyon to Granite Park in the Grand Canyon, and in the lower eight miles of the Little Colorado River, including its confluence with the Colorado River.

Historical and Current Range. Historically, humpback chub populations existed in the Little Colorado, Green, Yampa, White, and mainstem Colorado Rivers. The species was first described in 1946, and exact historical distributions within the Colorado River Basin cannot be confirmed.

Populations in the upper basin occur in canyon reaches of the mainstem Colorado, Green, and Yampa Rivers (Tyus et al. 1982). Populations exist in the Black Rocks and Westwater Canyon reaches of the mainstem Colorado River (Badame and Hudson 2003, Wick et al. 1981, Valdez and Clemmer 1982, Archer et al. 1985) and in Desolation and Gray Canyons on the Green River (Jasckon and Hudson, 2005). In Westwater Canyon an estimated 2,201 to 4,744 adults were present in 1998 to 2000 (Badame and Hudson 2003), and at Black Rocks an estimated 478 (confidence interval of 221 to 1,176) were present in 2003 (unpublished data, C. McAda personal communication, 2007). The population of adults in Desolation and Gray canyons on the Green River was estimated at 937 to 2,612 in 2001 to 2003 (Jackson and Hudson 2005). The Yampa Canyon population is thought to be nearly extirpated (Finney et al. 2006).

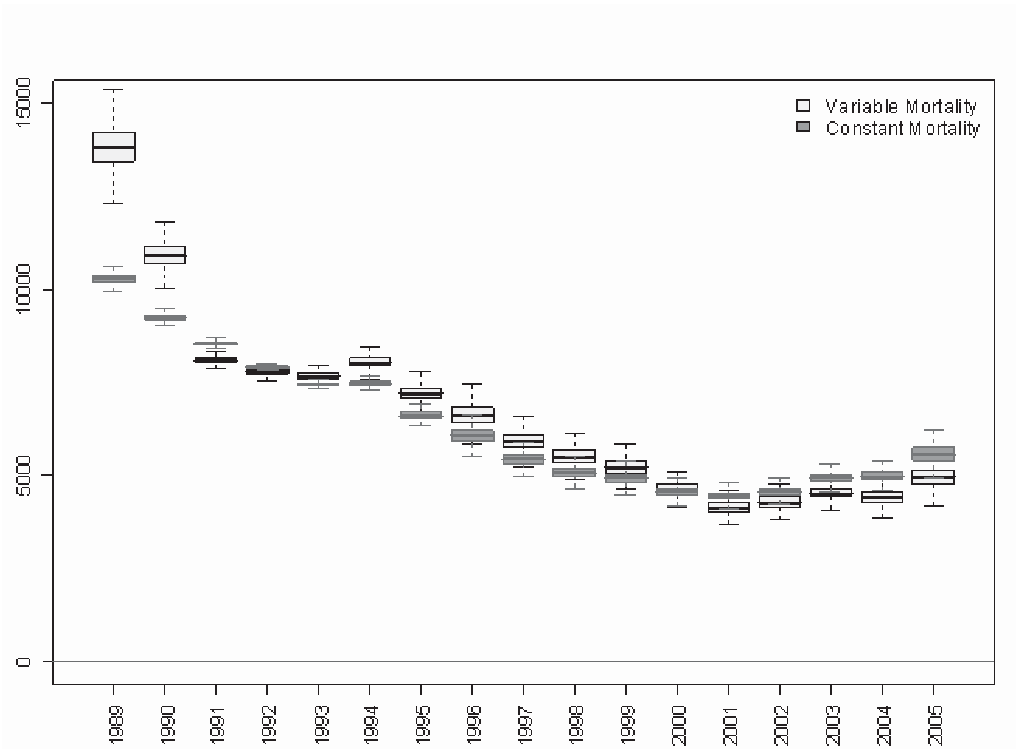
Populations within the Action Area. In the action area, humpback chub is present in the Marble and Grand Canyons of the Colorado River, and in the Little Colorado River for 13 km (8 miles) upstream from the river's mouth (Kaeding and Zimmerman 1983, Maddux et al. 1987). Valdez and Ryel (1995) identified 10 aggregations of humpback chub in the Grand Canyon, mostly near tributary inflows. Young-of-year humpback chub were reported from the warm spring at RM 30 in 1994 as compelling evidence of reproduction at that locale (Valdez and Masslich 1999). Also, young-of-year humpback chub were collected in substantial numbers in both 2005 and 2006 between RM 30 and the LCR, suggesting spawning success in the main channel Colorado River during those years (Ackerman 2007). Observations of this sort since closure of the dam are almost nonexistent and it is hypothesized that water temperatures warmer than the post-dam average may be largely responsible for the successful spawning activity.

In the Little Colorado River, Douglas and Marsh (1996) estimated a population size of 4,508 humpback chub. This population declined from 1989 to 2000 but appears to have stabilized between 2001 and 2005 (Figure R-2) at approximately 5,000 adult fish (USGS 2006a). Stabilization may be due in part to increased water temperatures caused by drought and warmer release temperatures from Glen Canyon Dam, experimental removal of non-native fish, and experimental water releases. The species has also been successfully translocated to above Chute Falls in the Little Colorado River, and the fish have spawned there (USGS 2006b).

Aside from mainstem reaches immediately below the LCR, YOY and juvenile humpback chub occur in the main channel Colorado River most commonly from RM 110-130 (Middlge Granite Gorge) and RM 160-200 (AGFD 1996; Trammell et al. 2000; Lauretta and Johnstone and Lauretta 2004, 2007; Ackerman 2006). The Middle Granite Gorge aggregation (which includes adults) has been stable or increasing in size since 1993 (Trammell et al. 2000) and may be sustained via immigration from the LCR spawning aggregation. Valdez et al. (2000) has identified this aggregation as the most likely candidate for a second spawning population in the main channel given favorable conditions (mainly temperature).

Observations of humpback chub below Diamond Creek are sporadic due to infrequent sampling. In the 1940s, five humpback chub were collected from the Colorado River near Spencer Creek (Miller 1944; Bookstein et al. 1985), and one juvenile humpback chub was reported from Spencer Creek in the 1950s (Wallis 1951; Kubly 1990). One adult humpback chub was captured downstream of Maxson Canyon (RM 244; RKM 407) in 1994 (Valdez 1994). More recently, four humpback chub were collected between Diamond Creek and Lake Mead during 2006 (AGFD, unpublished).

Figure R-2
Adult (age 4+) Humpback Chub Population Estimates (1989-2005) for the Little Colorado River.
Confidence Intervals are 95% Bayesian Credible Intervals. (Source: USGS 2006a)



Habitat. Humpback chubs use swift, deep, canyon stretches of river (Valdez and Clemmer 1982, Archer et al. 1985). Within the lower basin canyon reaches, adults occupy main channel eddies, and subadults are near shore (Valdez and Ryel 1995). Converse et al. (1998) report that the highest densities of subadult humpback chub in the Grand Canyon occur along vegetated shorelines. Kaeding and Zimmerman (1983) found this species in association with large travertine dams in the Little Colorado River. Maddux et al. (1987) captured young-of-the-year humpback chub in sandy runs and backwaters of the Little Colorado River. Valdez and Ryel (1995) found that subadult and adult humpback chub demonstrate diel depth preferences, using deeper water during the day and shallower water at night.

Although humpback chub are generally considered nonmigratory, migrations to spawning areas may occur from the main river to tributary streams, including the Little Colorado River (Kaeding and Zimmerman 1983). The abundance and persistence of the humpback chub in the Grand Canyon reach of the Colorado River may be linked to the use of the Little Colorado River for spawning and nursery habitat (Carothers and Minckley 1981).

In the Grand Canyon, humpback chub larvae are found almost exclusively in the warmer waters of the Little Colorado River (Carothers and Minckley 1981, Maddux et al. 1987) and in mainstem backwaters. Larvae tend to utilize silty bottom habitats. Later, humpback chub utilize a variety of habitats within a boulder strewn canyon environment (i.e., pools, riffles and eddies). They move between habitats dependent on life history needs and natural habitat change (NPS 1998).

Reproduction. Humpback chub reproductive timing is variable; ripe fish have been collected from April to July and at water temperatures of 11.5–23ºC. Under laboratory conditions, however, egg hatching success is greatest at 20ºC (Marsh 1985). Bulkley et al. (1981) estimate a final thermal preferendum of 24ºC for humpback chub during their first year of life (80–120 mm). Valdez (2006) summarized humpback chub temperature requirements as ranging from 16-22ºC with an optimum of 18ºC for spawning and ranging from 16-27ºC with an optimum of 19ºC for egg incubation.

Diet. Humpback chub are omnivorous (Valdez and Carothers 1998). Juvenile humpback chub forage near the substrate, feeding on benthic insect larvae and organic detritus (Carothers and Minckley 1981). Midge larvae, biting midge larvae, fly larvae, and planktonic crustaceans were found in the stomach contents of a juvenile humpback chub collected during the winter (Carothers and Minckley 1981). Adult humpback chub have been observed feeding on *Cladophora* and organic debris (Carothers and Minckley 1981). Valdez and Ryel (1995) found that adult humpback chub from the Little Colorado River and Middle Granite Gorge consumed primarily *Gammarus* sp. (freshwater amphipod), Simuliids (black flies), and terrestrial invertebrates. They concluded that food was not a limiting factor for juvenile and adult humpback chub.

Threats. Numerous researchers have identified that the major factor contributing to the decline of humpback chub and other large-river fishes has been the construction of mainstem dams, which had resulted in altered thermal and hydrologic regimes. Cold, stenothermic dam releases and reservoirs have replaced warm, riverine environments (Holden and Stalnaker 1975, Minckley et al. 1991, Mueller and Marsh 2002, USFWS 2002c). Competition and predation from non-native fishes that have adapted to these conditions have also contributed to decline of native fishes (Minckley and Deacon 1991). For further detailed information including examples, ramifications, and research needs pertaining of the effects of habitat modifications on native Colorado River fishes, see Tyus (1982), Minckley and Deacon (1991), Mueller and Marsh (2002), and USFWS (2002c). Spatial distribution of humpback chub in the Colorado River basin is limited by the species' affinity for and distribution of swift, deep canyon stretches of river within the system (Valdez and Clemmer 1982, Archer et al. 1985). The Colorado River exhibits diurnal and seasonal flow fluctuations in response to variable hydroelectric demands. The diurnal fluctuations in stage approach 2 feet, in contrast to daily flow changes of less than a foot prior to impoundment. The temporal stability of inshore, shallow water, backwater, and low-water environments used by native fish for resting, feeding, spawning, and nursery areas is greatly decreased by existing fluctuating flows (Maddux et al. 1987).

The cooler temperature of the Colorado River due to Glen Canyon Dam releases is strongly implicated as a primary cause of the humpback chub population decline. Egg hatching success of humpback chub is highly temperature dependent, with the highest success occurring at a water temperature of about 20ºC and very low success at temperatures below 15ºC (Hamman 1982, Marsh 1985). Water released by Glen Canyon Dam from Lake Powell is generally cold, with temperatures ranging from 6–12ºC (Maddux et al. 1987). However, recent release temperatures approaching 15°C along with downstream warming may benefit various life stages of humpback chub. When low release temperatures occur, reproductive success of humpback chub in the mainstem Colorado River is drastically reduced below Glen Canyon Dam. . If successful spawning occurred in the mainstem Colorado River, humpback chub would still be adversely affected by the daily fluctuations in discharge below Glen Canyon Dam, which can dry and introduce colder mainstem water to backwaters used by young-of-the-year humpback chub.

Interactions with the many introduced nonnative species continue to threaten the existence of humpback chub. Nonnative species tend to be highly competitive and productive generalists. Habitat and dietary overlap exists between humpback chub and many nonnative species. In the upper basin, common carp (Behnke and Benson 1983, Valdez 1990), green sunfish, largemouth bass, redside shiner (Joseph et al. 1977), red shiner (Joseph et al. 1977, Valdez 1990), and channel catfish (Joseph et al. 1977, Behnke and Benson 1983, Valdez 1990) use habitats with similar environmental conditions as humpback chub. Valdez and Ryel (1995) found habitat and dietary overlap between rainbow trout and humpback chub in the Grand Canyon. Spawning and egg hatching temperatures are similar for humpback chub and common carp, fathead minnows, and channel catfish (Valdez and Carothers 1998). Nonnative fish spawning sympatrically (i.e., in the same area) may displace humpback chub or reduce success. Some species are also predators on humpback chub. Predation by channel catfish, brown trout, rainbow trout, and black bullhead on humpback chub has been documented (Valdez and Ryel 1995).

R.2.4.5 Razorback Sucker

Legal Status. Razorback sucker were listed as endangered under the ESA in 1991. Critical habitat has been designated and it includes the Dirty Devil arm of Lake Powell and the Colorado River and its 100 year floodplain from the confluence of Paria River (located below Glen Canyon Dam) to Hoover Dam, including Lake Mead to its full pool elevation (59 FR 13399).

Historical and Current Range. Razorback sucker was historically widespread and common throughout the larger rivers of the Colorado River Basin, from Sonora and Baja, California, into Arizona, Colorado, Nevada, New Mexico, and Wyoming (Minckley et al. 1991, Marsh 1996). Gilbert and Scofield (1898) noted particularly high razorback sucker abundance in the Lower Colorado River Basin (LCRM) near Yuma, Arizona.

To date, the only substantial natural razorback sucker recruitment (low, yet steady numbers) and documentation of razorback sucker progression through all life stages in the LCRB occurs in Lake Mead, with limited and sporadic captures of naturally occurring fish throughout the remainder of the LCRB (Marsh and Minckley 1989; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker and Holden 2003; Welker and Holden 2004). Razorback sucker do occur above Lake Powell and some may wash down into Lake Powell and persist at the inflow areas. However, there is not a regionally significant population of razorback sucker within Lake Powell. Razorback sucker are rarely caught in the Colorado River between Glen Canyon Dam and Lake Mead and are widely considered extirpated from this reach (Gloss et al. 2005). Annual monitoring at random locations in this reach of the river has not captured any razorbacks in more than 15 years. In 1997, 15 hatchery-reared razorback suckers were released into the lower gorge by the Hualapai Tribe (NPS 2005). Thus, it is possible that a few individuals could still be present.

Several investigators have reported hybrids between razorback suckers and flannelmouth suckers in Grand Canyon (Suttkus et al 1976; Maddux et al. 1987; Valdez and Ryel 1995). Although hybridization between these species has been reported for many years (Hubbs and Miller 1953; McAda and Wydoski 1980), the incidence in Grand Canyon appears high relative to the number of razorback suckers, especially in the LCR where these fish concentrate during spawning (Douglas and Marsh 1998).

Populations within the Action Area. Razorback sucker populations are present in Lake Havasu, Lake Mohave, Lake Mead, as well as in the Cibola High Levee Pond and Senator Wash in the lower Colorado River Basin. This species has been stocked in Lakes Mohave, Havasu, and Mead as well as in the Colorado River below Parker Dam (USFWS 2001). The population estimate for Lake Mohave is 3,000 to 4,000 fish (Stefferud et al. 2003), and less than 300 fish may be present in Lake Mead (USBR 2000). Spawning and recruitment of razorback suckers has been documented for Lake Mead through a monitoring program funded by the Bureau of Reclamation and the Southern Nevada Water Authority (Welker and Holden 2003). Larvae have been collected, and age calculations for juvenile to adult fish are 4 to 35 years indicating that recruitment has taken place. Spawning occurs in Echo Bay and Las Vegas Bay/Wash. Spawning also appears to be occurring in Lake Havasu, Senator Wash, and in the river below Parker Dam with low recruitment (Moyle 2002). Due to spawning and recruitment of razorback suckers in Lake Mead, individuals of this species could move upstream into the Colorado River from the lake.

No population estimates of razorback sucker have been conducted in the upper basin, The species is known to be present in Lake Powell at the mouths of the Dirty Devil, San Juan, and Colorado rivers (USFWS 2006), in the Green River to the confluence with the Colorado River (Modde et al. 2002), and in the San Juan River (Pfeifer et al. 2002). Stocking is being undertaken to augment the populations it the upper basin. Razorback suckers from previous stocking were collected in 2005 (46 individuals) and 2006 (64 individuals) during nonnative control in the lower San Juan River with three adults captured below the waterfall (RM 0.6) in 2005 and one adult taken below the waterfall in 2006 (Jackson 2006, Elverud and Jackson 2007). Approximately one to four individuals are regularly captured in the annual surveys of the San Juan arm of Lake Powell, and all are from hatchery stock (Gustaveson 2007). Gillnet surveys in Lake Powell have recorded one adult razorback in 1975 at the Good Hope station, two at the Wahweap station in 2006, and seven in the San Juan arm in 2004 plus 2006 (Utah DWR, 2007). Larval drift data from the middle Green River in Utah strongly suggests successful reproduction by stocked fish (Bestgen and Haines 2006), and wild juvenile suckers have been collected in the lower San Juan River in recent years.

Habitat. . Bestgen (1990) indicates that razorback sucker may have historically been uncommon in the turbulent canyon reaches of the Colorado River, citing research by Tyus (1987) and Lanigan and Tyus (1989) that suggests that razorback sucker in the Green River (the largest known riverine population) were typically found in calm, flatwater river reaches, not turbulent, fast-water canyon reaches. This trend is evident even within basins, as razorback sucker are typically collected in sand-bottomed, low gradient, flatwater reaches outside of the spawning period. However, razorback sucker inhabit virtually all components of riverine habitat at some point in their lives. In particular, low-velocity habitats such as backwaters, sloughs, oxbow lakes, and other slackwater habitats within the main channel were important for razorback sucker (Holden 1973, Holden and Stalnaker 1975, Behnke and Benson 1980, Minckley 1983). Seasonally submerged off-river habitats, including bottomlands and other marsh-like, lowland habitats, may have also been important habitat for razorback sucker prior to the construction of mainstream dams and the resultant changes in flow regimes, especially during spring-runoff periods (Tyus and Karp 1989, Bestgen 1990, Osmundson 2001).

More recent authors have documented that habitat selection by adult razorback sucker changes seasonally. Tyus and Karp (1990) document habitat use by adult razorback sucker to consist of flooded areas during spring months. Radiotelemetry efforts by Tyus (1987) identified adult fish utilizing near-shore runs during the spring, but they subsequently shifted habitat use during the summer to shallow waters associated with submerged mid-channel sandbars, with little use of backwaters. This suggests that the use of backwaters by razorback sucker may be overstated and an artifact of relatively easy capture with electrofishing rather than actual habitat use and preference. Osmundson and Kaeding (1989) reported adult razorback using pools and slow eddies from November through April, shifting to runs and pools from July through October. They also note increased backwater habitat use by adult fish during the months of May and June, the typical Upper Colorado River Basin (UCRB) spawning period.

Water velocity selection by adult razorback sucker is also typified by seasonal shifts in preferences. Tyus (1987) noted that during the summer, razorback sucker typically were found utilizing velocities averaging 0.5 m/s, while in the winter months adult fish were typically found in currents moving 0.03-0.33 m/s. These findings corroborate hypotheses and findings of Lanigan and Tyus (1989) and Minckley et al. (1991) that few adult razorback sucker utilize swift, whitewater habitats (e.g., Marble and Grand Canyons of the LCRB), although other efforts have documented movement of radio-telemetered fish through these locations (Tyus and Karp 1990). Furthermore, it becomes apparent that razorback sucker in a natural river setting do not appear to utilize solely backwater habitat types, although it appears that these habitats are important to young-of-year and juveniles. Lastly, adult razorback sucker have been reported to select shallower depths during the summer months

(0.9-1.65 m) while typically utilizing deeper depths during the winter months (1.65-2.16 m) (Osmundson and Kaeding 1989).

Razorback sucker are present in lentic environments in the LCRB, where they sometimes exhibit interesting and rather extensive habitat use. The majority of such information suggests that lentic-dwelling razorback sucker use a wide variety of habitats, including vegetated areas, littoral shoreline habitats, and substrates ranging from silt and sand to gravel and cobble. Adult razorback sucker have been documented via sonic surveillance to typically occupy depths less than 30 m (averaging between 3.1-16.8 m) and are generally located within 50 m from the shore during winter months (less than 30 m from shore during peak spawning activity). However, during summer months, adults were located at deeper depths, often surpassing 30 m, in an effort to hold body temperatures between 18-22 degrees C, a behavior thought to maximize bioenergetics (Marsh and Minckley 1989; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Mueller et al. 2000; Abate et al. 2002; Welker et al. 2003; Welker and Holden 2004). Thermal preferendum for adult razorback sucker was estimated to lie within the range of 22-25 degrees C based on laboratory observations (Bulkley and Pimentel 1983).

In lentic (reservoir) settings razorback sucker larvae have been collected over a variety of habitat types, but they typically are collected over or near areas frequented by adult spawning aggregates. As a result, the majority of larval fish are captured over gravel and cobble, at near-shore locations, typically at depths of 0.0-4.9 m (Sigler and Miller 1963; Minckley 1983; Bozek et al. 1984; Marsh and Langhorst 1988; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker et al. 2003; Welker and Holden 2004). In the Green River larval razorback sucker are entrained by spring flows into backwater and flooded bottomland habitats, where they benefit from warmer temperatures and abundant food resources (Tyus 1987, Muth et al. 1998). Historically, high spring flows flooded low-lying areas along the river and redistributed recently emerged and drifting larval razorback sucker into these food-rich backwaters and other seasonally flooded bottomlands, providing unique nursery habitats for razorback sucker (Tyus and Karp 1989, 1990; Modde 1996; Modde et al. 1996; Modde et al. 2005).

Habitat important to the juvenile life stages of razorback sucker remains relatively understudied, as catches of this size class remains minimal, presumably due to the predatory and competitory impacts of non-native species (Tyus 1987, Bestgen 1990, USFWS 1998b). The majority of juvenile, riverine catches come from the UCRB (Taba et al. 1965, Gutermuth et al. 1994, Modde 1996), with almost non-existent data on juvenile habitat use from the LCRB. Brandenburg et al. (2005) recently captured wild-spawned juvenile razorback sucker in the San Juan River. All of the juveniles in the San Juan River were found using seines in shoreline habitats including backwaters, embayments, and other lower-velocity habitats.

Reproduction. Although spawning razorback sucker have been collected over a variety of substrates, the majority of spawning individuals tend to be captured over clean gravel- and cobble-sized substrates (Douglas 1952, Tyus 1987, Bozek et al. 1990, Tyus and Karp 1990, Minckley et al. 1991). In UCRB rivers spawning occurs during the ascending limb of the hydrograph (Modde et al. 2005), which apparently an important adaptive feature for larvae as discussed below. Reservoir-spawning razorback sucker have been documented to successfully spawn in various LCRB impoundments. Spawning populations have been located in Lake Mead (Jonez and Sumner 1954; Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Welker and Holden 2003; Welker and Holden 2004), Lake Mohave (Bozek et al. 1984, Marsh and Langhorst 1988, Mueller 1989, Bozek et al. 1990), Lake Havasu (Douglas 1952, Minckley 1983), Senator Wash Reservoir (Medel-Ulmer 1980), and likely other locations. Spawning fish have been documented to congregate near river inflow areas that tend to be somewhat more turbid than the majority of the available spawning areas (Jonez and Sumner 1954; Holden et al. 1997, 1999).

The spawning season for razorback sucker has been reported to begin as early as November in some LCRB reservoirs and documented to continue through June in some populations of the UCRB. In upper basin riverine habitats, ripe razorback sucker have been collected from mid April to mid June, typically over a very limited time frame (4-5 weeks) (Tyus 1987; Osmundson and Kaeding 1989; Tyus and Karp 1989, 1990; Bestgen 1990). However, in lentic lower basin habitats the majority of spawning generally is carried out between January and April, months when water temperatures are typically within the range of 10-15 degrees C (Bestgen 1990). Male razorback sucker remain ripe for a period of 2-28 days, while females apparently are ripe for less time (2-15 days) in the Green River (Tyus and Karp 1990) but appear to have extended periods of sexual activity in lower basin reservoirs (Holden et al. 2001).

Research efforts by Bozek et al. (1990) show that successful incubation of razorback sucker eggs in Lake Mohave occurs between 9.5-15.0 degrees C, and in the laboratory successful embryo hatching occurs at 10-20 degrees C. Hatching (eggs at a controlled 15 degrees C) was reported to occur in 5.2-5.5 days (Minckley and Gustafson 1982). Egg mortality has been attributed to fluctuating water levels, scouring by currents and/or wave action, suffocation due to silt deposition, and non-native egg predation (Minckley 1983, Bozek et al. 1984). Fertilized gametes are reported by Minckley and Gustafson (1982) as adhesive for a 3-4 hour duration post fertilization, with cleavage being completed within 24 hours, gastrulation occurring at 34 hours, and blood circulation becoming established at 117 hours.

Valdez (2006) summarized temperatures required for spawning and egg incubation for this species as 12-22ºC with an optimum of 18ºC and 14-25ºC with an optimum of 19ºC, respectively.

Diet. Razorback sucker diet composition is highly dependant upon life stage, habitat, and food availability. Upon hatching, razorback sucker larvae have terminal mouths and shortened gut lengths (less than 1 body length) which in combination, appears to facilitate and necessitate selection of a wide variety of food types. Exogenous feeding occurs at approximately 10 mm TL (approximately 8-19 days), after which larvae from lentic systems feed mainly on phytoplankton and small zooplankton, while riverine inhabiting larvae are assumed to feed largely on chironomids and other benthic insects (Minckley and Gustafson 1982, Marsh and Langhorst 1988, Bestgen 1990, Papoulias and Minckley 1990, USFWS 1998b). Papoulias and Minckley (1992) reared larval razorback sucker in three different ponds containing different densities of food resources to demonstrate that increased growth was positively related to invertebrate densities, suggesting the importance of larval food switching from algal and detrital food items to a diet enriched with invertebrates. Papoulias and Minckley (1990) show that larval razorback mortality is minimized when food levels are within the range of 50-1,000 organisms/L.

Later during growth (age and size information unknown, but at some point during the juvenile life stage), razorback sucker undergo an ontogenetic shift in mouth morphology, with the mouth becoming more inferior and allowing for more efficient access to benthic food sources. Thereafter, razorback sucker likely consume a variety of benthic-associated food items (USFWS 1998b).

Threats. Numerous researchers have identified that the major factor contributing to the decline of razorback sucker and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, dynamic, riverine environment (Holden and Stalnaker 1975, Joseph et al. 1977, Wick et al. 1982, Minckley et al. 1991). This change in the physical environment presumably allowed for an increase in competition and predation from nonnative fishes, which are successfully established in the Colorado River and its reservoirs and have also contributed to native fish population declines (Minckley et al. 1991). In the middle Green River, also, lower peak flows (due to regulation) are thought to limit floodplain nursery habitat availability for larval fish (Muth et al. 2000).

R.2.4.6 Colorado Pikeminnow

Legal Status. Colorado pikeminnow were listed as endangered by U.S. Fish and Wildlife Service in 1967 and given full protection under the Endangered Species Act of 1973. Critical habitat was designated for Colorado pikeminnow in the upper Colorado River basin effective April 20, 1994. Critical habitat includes the Dirty Devil arm and the San Juan arm of Lake Powell in the action area. No critical habitat was designated in Arizona in the lower basin. Outside Arizona, six reaches in the upper Colorado basin [totaling 1848 km (1148 miles)], have been designated as critical habitat (AGFD 2001). Critical habitat is designated within the Colorado, Yampa, White and San Juan Rivers in the upper basin (59 FR 13384, March 21, 1994).

Historical and Current Range. Historically, Colorado pikeminnow were found in the mainstem of the Colorado River and its tributaries, from Wyoming to the Gulf of California. Currently, the species persists only in the upper Colorado River basin. In the upper Colorado River basin, the highest concentration of Colorado pikeminnow occurs in the Green River, from the mouth of the Yampa River to its confluence with the Colorado River. They have been reintroduced in the Salt and Verde Rivers in Arizona. Reintroductions are considered experimental, nonessential populations and reproducing populations of Colorado pikeminnow have not been established (Maddux et al. 1993).

Populations within the Action Area. The Colorado pikeminnow is present in the Colorado River downstream to Lake Powell (USFWS 2006), and the species is present in the San Juan River where it is also stocked (Pfeifer et al 2002). A few individuals are also present in Lake

Powell (USBR 2000). Nonnative fish control efforts in the lower San Juan River in 2005 and 2006 captured 287 and 256 juvenile pikeminnows, respectively, with only two collected below the waterfall in 2005 (Jackson 2006, Elverud and Jackson 2007). Studies of stocked Colorado pikeminnows in the San Juan River from 2002 through 2005 (Golden et al. 2006) collected 22 young pikeminnows between Clay Crossing and Lake Powell from November 2004 to November 2005. These data indicate that few individuals of Colorado Pikeminnow are present in the inflow area below the waterfall when Lake Powell elevations are low.

Habitat. Colorado pikeminnow are fish-eating, long-lived, large-river fish that use a variety of substrates, depths, and velocities. Historically, large adults were found in the turbid, silty waters of the Colorado River and large pools in tributaries to the Colorado River. Currently, they have a home range of approximately 5 km and move around the main stem river in their range. They utilize areas with slower currents, such as backwaters or near shore habitat. During spring and early summer, adult fish use areas inundated by spring flooding. Spring inundation of lowlands is believed to be important to the overall health of this species. Thermal adult preference is 25.3ºC (Black and Bulkley 1985).

Adult Colorado pikeminnow can display long-distance (up to 322 km) migratory behavior in sexually mature fish, and this behavior is important to reproduction (Maddux et al. 1993). Migration in the upper Colorado begins in early summer, possibly in response to falling water levels and increasing water temperatures. Colorado pikeminnow spawning migrations are initiated at water temperatures of 14-20ºC, while spawning occurs at an average temperature of 22ºC in late June to early August (Moyle 2002, 159). Colorado pikeminnow demonstrate a fidelity to spawning locations (Tyus 1985; Tyus 1990; Wick et al. 1983), with reproduction occurring in whitewater canyons. Fertilized eggs adhere to rocks and gravel. After spawning, adult fish return to their home range (Moyle 2002, 159).

In laboratory experiments, embryo hatching success was highest at 20ºC (Marsh 1985). Once larval pikeminnow emerge, they undergo a period of drift to reach nursery habitat. During the larval drift, they may be transported up to 161 km downstream (Tyus and Haines 1991). Nursery areas consist of ephemeral backwaters and shoreline embayments with little or no current (Tyus and Haines 1991). Bestgen (1996) reports that Colorado pikeminnow larval growth rate declines at water temperatures below 22ºC. Temperatures required for spawning and egg incubation summarized by Valdez (2006) are 16-14ºC with an optimum of 22ºC and 19-25ºC with an optimum of 22ºC, respectively.

Juveniles use quiet water habitats but move in and out of the habitats according to water temperatures. Juveniles prefer warmer temperatures in backwater areas rather than the cooler water temperatures in the main stem river. Bulkley et al. (1981) estimate the final thermal preferendums for juvenile Colorado pikeminnow to be 24.6ºC. Young Colorado pikeminnow have very specific streamflow and temperature requirements. Kaeding and Osmundson (1988) correlated lower water temperatures with reduced growth of age-0 Colorado pikeminnow and concluded that Colorado pikeminnow (45-100 mm) would not grow at water temperatures below 13ºC.

Reproduction. Naturally reproducing populations are presently found in the Green, Yampa, upper Colorado, Gunnison and San Juan Rivers. Approximately 8,000 adults spawn in the Green River basin (USFWS 2002d, Appendix A-2); 1,400 adults in the Yampa River (USFWS 2002d, Appendix A-2); and about 600–900 adults (USFWS 2002d, Appendix A-2) are believed to spawn in the upper Colorado River and near Grand Junction, Colorado, and in the lower Gunnison River (USFWS 2002d, Appendix A-2). Adult spawning estimates in the San Juan River range from 19 to 50 fish (USFWS 2002d, Appendix A-2). Average fecundity of 24, 9 year old females was 77,400 (range, 57,766–113,341) or 55,533 eggs/kg, and average fecundity of 9 ten-year old females was 66,185 (range, 11,977–91,040) or 45,451 eggs/kg (USFWS 2002d, Appendix A-2). Hybridization with other species is not known to occur.

Diet. Juveniles up to 50 mm in length consume zooplankton and insect larvae. Colorado pikeminnow from 50-100 mm in length feed on insects, and individuals larger than 200 mm eat mostly fish (Vanicek and Kramer 1969).

Threats. Numerous researchers have identified that the major factor contributing to the decline of Colorado pikeminnow and other large-river fishes has been the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a once warm, riverine environment (Holden and Stalnaker 1975, Minckley 1991, Mueller and Marsh 2002, USFWS 2002d). Competition and predation from non-native fishes that are successfully established in the Colorado River and its reservoirs have also contributed to their decline (Minckley and Deacon 1991, USFWS 2002d).

R.2.4.7 Kanab Ambersnail

Legal Status. Kanab ambersnail was listed as an endangered species in 1992 under the ESA (USFWS 1992). No critical habitat has been designated in the action area. The species is undergoing a 5-year review by the FWS, including a genetic evaluation of the species relatedness to other *Oxyloma*.

Historical and Current Range. The genus *Oxyloma* has a broad distribution (North America, Europe and South Africa) with two species recognized in the southwestern U.S.: *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 three springs: one at Three Lakes, near Kanab, Utah, and two in the in Grand Canyon National Park, Arizona, one at a spring and hanging garden at Colorado River mile 31.5 R known as Vaseys Paradise and a translocated population at Upper Elves Chasm, at Colorado river mile 116.6mi L (Gloss et al. 2005). In the Kanab area, two populations were known to exist, but one was extirpated by desiccation of its habitat. The remaining population at Three Lakes is located on private lands at several small spring-fed ponds on cattail (*Typha* sp.) (Clarke 1991).

KAS populations in the American Southwest are believed to be relictual populations from the Late Pleistocene ice age, when springs, seeps, and wetland habitat were more abundant in the region (Spamer and Bogan 1993, Szabo 1990). Historically, the Grand Canyon region may have harbored many populations of ambersnails in close proximity to each that are now lost under Lake Powell. Through analysis of historic photographs of the region, an increase in the vegetative cover along the Canyon to river level has occurred since the completion of the Glen Canyon Dam in 1963 (Turner and Karpiscak 1980). This increase in cover, the reduction in beach-scouring flows, and the introduction of non-native water-cress (*Nasturtium officinale*) has lead to an increase in suitable KAS habitat area at Vaseys Paradise of more than 40 percent from pre-dam conditions (Stevens et al. 1997a). It is believed that a similar increase in abundance of KAS occurred in this region over this same time period.

Intensive search efforts at more than 150 springs and seeps in tributary canyons to the Colorado River between 1991 through 2000 found no additional KAS in the region (Sorensen and Kubly 1997, 1998, Meretsky 2000, Meretsky and North 2000, Webb and Fridell 2000). As part of the KAS recovery effort required under the ESA, three natural springs along the Colorado River corridor were stocked with young snails in September 1998 (AGFD 1998). Release sites were selected in areas above the historic flood elevation (~100,000 cfs stage) and where populations would not be affected by dam operations. One translocation site, Upper Elves Chasm, has established as a new population and continued monitoring efforts have detected numerous KAS persisting and reproducing at the initial release area, including migration into suitable adjacent habitat (Gloss et al. 2005).

Populations within the Action Area. Populations within the action area occur along the Colorado River at Vaseys Paradise and a spring and hanging garden at Colorado River Mile 31.5 R. No other populations are known within the action area.

Habitat. The Kanab Ambersnail is dependent upon wetland vegetation for food and shelter. KAS lives in association with watercress (*Nasturtium*), monkeyflower (*Mimulus*), cattails (*Typha*), sedges (*Carex*), and rushes (*Juncus*). KAS populations in the Grand Canyon region occur in areas where water sources originate from limestone or sandstone geologic strata (Stevens et al. 1997a). Stevens et al. (1997a) found KAS predominantly using crimson monkeyflower and water-cress for food and shelter at Vaseys Paradise and therefore identified these two species as key habitat components for KAS. 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 (*Carex aquatilis*), rushes (*Juncus* sp.), cattails (*Typha* sp.), water-cress, helleborine orchids (*Epipactis gigantea*) and grasses (Nelson and Sorensen 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 KAS survival (Sorenson and Nelson 2002).

Reproduction. Kanab ambersnail are believed to live approximately 12-15 months and are hermaphroditic and capable of self-fertilization (Clarke 1991, Pilsbry 1948). Mature KAS 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 KAS can range between 25 and 80 percent (Stevens et al. 1997a & 1997b and IKAMT 1998).

Diet. This species of land snail feeds on plant tissue, bacteria, fungi and algae. It scrapes this food off of plants by means of a radula or rasp tongue. Stevens et al. (1997b) observed KAS feeding largely on crimson monkey-flower and water-cress.

Threats. Current threats to KAS include loss and adverse modification of wetland habitats, which are scarce in this semi-arid region (USFWS 1995c). The habitat for the Utah population is at risk due to commercial development by the private landowner. Historically, the Grand Canyon experienced annual floods of 90,000+ cubic-feet per second (cfs) and KAS were likely swept downstream and drowned (Stevens et al. 1997a). Today, Glen Canyon Dam limits such flood events, although several flows >45,000 cfs have occurred in the last 30 years (IKAMT 1998). For example, during the March 1996 experimental beach/habitat-building flow (BHBF) in the Grand Canyon, up to 16 percent of KAS habitat at Vaseys Paradise was lost or degraded and hundreds of snails were lost. Recovery of this habitat to pre-flood conditions required over two years (IKAMT 1998, Stevens et al. 1997b).

On a lesser scale, 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. Due to steep slopes and a dense cover of poison ivy at this location, the impacts from recreationists are reduced. 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 (*Oncorhynchus mykiss*) in the stream mouth, 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, USFWS 1995c). Hard evidence of KAS consumption and 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). Another natural threat is bighorn sheep. Water sedge, a plant with patchy distribution in Kanab ambersnail habitat, is a source of forage for bighorn sheep (*Ovis canadensis*), especially during a drought. As a result, the springs at Vasey's Paradise are now habitually visited by bighorn sheep, resulting in vegetation used by the snails being regularly trampled (Gloss et al. 2005).

R.3 Effects Analysis

R.3.1 Analysis Methodology and Assumptions

This section describes the methods and assumptions used to conduct the analysis of potential effects of the proposed action on the evaluated species in the Lake Powell to Lake Mead portion of the action area. Methods and assumptions used to conduct the analysis of SNWA's interdependent actions on the Muddy and Virgin River portions of the action area are described in Attachment B.

The approach for analyzing effects of the proposed action for the Lake Powell to Lake Mead portion of the action area consisted of comparing Lake Powell elevations, river flows, average monthly river temperatures at Lees Ferry, the Little Colorado River confluence and below Diamond Creek, and river sediment transport under the baseline condition to conditions expected under the proposed action and evaluating if differences in hydrologic conditions under the proposed action would affect ESA-listed, proposed, and candidate species and designated critical habitats.

R.3.1.1 Lake Powell Reservoir Elevation and Releases

Future Colorado River system conditions under the baseline 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 implemented in 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 historic record of natural flow in the river system over the 100-year period from 1906 through 2005 from 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 which 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 Final EIS.

CRSS modeling outputs used to conduct the analysis of effects are presented in Attachment C. CRSS model outputs included the relative probability of different sized 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.

R.3.1.2 Water Temperature

Lake Powell undergoes seasonal transformations that can dramatically affect the temperatures of both the reservoir and the 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. Reservoir draw downs can 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 CRSS output of dam release and reservoir elevations was used in the CE-QUAL-W2 model to establish a relationship between reservoir elevations and dam release temperatures and project the impact of reservoir draw down on dam release temperatures. Calibration of the CE-QUAL-W2 model for Lake Powell used historic temperature profiles from 1990 to 2005 at 13 reservoir stations.

This 15-year data set provided a limited range of historic reservoir elevations, inflows, and releases. By using a combination of historic and modeled data for various reservoir elevations, and by analyzing the impact of a repetition of the recent drought years, dam release temperatures for a larger range of reservoir elevations could be analyzed.

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 one mile downstream of the Little Colorado River confluence; and the Diamond Creek gaging 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. This range is depicted graphically in Attachment C for reference and includes a minimum and maximum monthly temperature at three river locations for the 10^{th}, 50^{th}, and 90^{th} percentile Lake Powell elevation release condition. However, to provide a more meaningful comparison, this analysis used the average of the potential range as the basis of impact analysis. Both the temperature range and average temperatures are provided in Attachment C (Figures BA-18 through BA-27, and Tables BA-5 through BA-7).

Average river temperature by month at Lees Ferry, Little Colorado River confluence and Diamond Creek confluence were evaluated to identify whether the proposed action would affect river temperature compared to baseline conditions. Temperature model results were used to evaluate potential effects to various life stages of the evaluated fish species. Additional information on the water quality modeling methodology is available in Section 4.5 of the Final EIS.

R.3.1.3 Sediment Transport

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 R-6 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 ESA-listed fish.

R.3.1.4 Effects of Climate Change

The hydrologic model, CRSS, used as the primary basis of the 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 historic record to protect future inflows. The historic 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.

Table R-6
Relationship of Glen Canyon Dam Annual Release Volumes to 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

The Fourth Assessment Report (Summary for Policymakers) of the Intergovernmental Panel on Climate Change (IPCC), published in April of 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 is 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.

Reclamation has been involved in a multi-faceted research and development program over the past three years to improve its risk assessment capabilities regarding projected climate change in the Colorado River Basin. Key components of this program include:

- Sponsorship of NRC's Committee on the Scientific Bases of Colorado River Basin Water Management in collaboration with the California Department of Water Resources, the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, and the National Research Council's (NRC) Water Science and Technology Board

  This study culminated in a report published in early 2007, "Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability". Among several conclusions and recommendations, this report concluded that the trend of increasing mean temperatures across the Colorado River Basin over the 20th century and into the 21st century is likely to continue and although there is less consensus regarding future trends in precipitation and runoff, the preponderance of the scientific evidence suggests warmer future temperatures will reduce future streamflow and water supplies and contribute to increase the severity, frequency, and duration of future droughts. It is anticipated that the Final EIS will include the executive summary of this report as Appendix T.

- Collaboration with several climate researchers to assess the state of knowledge regarding the potential impacts of climate change on the Colorado River Basin, to assess methodologies that would be appropriate to quantify future conditions, and to prioritize future research and development needs

  This work culminated in a report titled "Review of Science and Methods for Incorporating Climate Change Information into Reclamation's Colorado River Basin Planning Studies". Among several conclusions and recommendations, this report concluded that for shorter look-ahead horizons (e.g., less than 20 years), interannual and decadal variability is likely to be a more significant source of uncertainty than the uncertainty due to near-term climate change. Although paleoclimatic information may not necessarily represent future climate scenarios, this information may be useful in framing assumed variability in future hydrologic sequences, particularly with respect to drought potential. It is anticipated that the Final EIS will include this report in its entirety as Appendix U.

- Collaboration with several research partners including the USGS, NOAA, and various universities to improve the accuracy and spatial resolution of the output data from the climate change models to enable use in CRSS

- Improvements to the decision-modeling framework (including the CRSS model and associated data handling and analysis tools)

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 the Final EIS and this BA 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 has been 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 1244 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. Furthermore, 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 this potential, the proposed action includes operational elements that would respond if these impacts are realized during the interim period (2008 through 2026). In particular, the proposed action includes a coordinated operation element that allows for the reduction of Lake Powell's release below the current minimum objective release of 8.23 mafy (down to a new proposed minimum of 7.0 maf) if water in storage of Lake Powell decreases to specified levels. In addition, the proposed action includes a storage and delivery mechanism that is designed to enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead. Finally, the proposed action includes a shortage strategy at Lake Mead that would result in additional shortages being applied, after appropriate consultation, if Lake Mead water surface elevations were to drop below elevation 1,025 feet msl.

R.3.2 Direct and Indirect Effects of the Proposed Action

Potential effects of the proposed action on the evaluated species could result from changes in Lake Powell reservoir storage and release operations from baseline operations. The potential hydrologic effects could result in changes in the range and duration of the water elevations maintained in Lake Powell, river flow, river temperature, and sediment transport that support habitat conditions for the evaluated species. The following section describes the potential effects of the proposed action on the evaluated species from Lake Powell to the upper end of Lake Mead and summarizes the effects of SNWA's interdependent actions that are evaluated in Attachment B.

R.3.3 Species Effects

R.3.3.1 Southwestern Willow Flycatcher

Based on the following analysis, the proposed action in combination with SNWA's interdependent action may affect and is likely to adversely affect the southwestern willow flycatcher through occasional, temporary desiccation of occupied 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. Conversely, a reduction in flows could have adverse effects on riparian and marsh vegetation, which could adversely affect southwestern willow flycatcher. In April and May, the 90^{th} percentile flows under the proposed action are higher than baseline conditions (Attachment C, Figures BA-9 and BA-10). 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 90^{th} 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 baseline conditions, in part because this action would allow for an annual release lower than 8.23 maf under certain circumstances (Attachment C, Table BA-4). These lower annual releases would result in lower hourly maximum flows as well as lower monthly low flows than baseline (Attachment C, Table BA-3). However, the probability of an annual release of less than 8.23 maf is relatively low (Attachment C, Table BA-4). Southwestern willow flycatcher nest in primarily tamarisk shrub in the lower Grand Canyon which is quite 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 is almost always either equal to or greater than under baseline conditions (Attachment C, Figures BA-9 through BA-13). Under these conditions, flycatcher habitat conditions would be expected to be the same or improved relative to baseline conditions. During periods of the breeding season that flows could be less than under baseline conditions (10^{th} percentile flows), the potential exists for lowering of groundwater elevations adjacent to the channel to decline, which could desiccate occupied nesting habitat and result in take of southwestern willow flycatcher. The probability for such take is considered to be low and the level of any such take would be low because only a few nest sites are known from this reach of the Colorado River, as indicated in Section 2.4.1 of this BA. Furthermore, the effect of take, should it occur, would be temporary because nesting habitat conditions are expected to be restored during periods when the flows are at or above the 50^{th} percentile (Attachment C, Figures BA-9 through BA-13). The level of this effect, however, is not expected to substantively affect the abundance or distribution of southwestern willow flycatcher in the action area or regionally.

As indicated in Attachment B, interdependent actions on the Muddy and Virgin Rivers are to not expected to result in take of southwestern willow flycatcher nor appreciably diminish the value of critical habitat designated along the Virgin River for flycatcher conservation or the value of critical habitat for survival or recovery of the species.

R.3.3.2 Yellow-billed Cuckoo

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the yellow-billed cuckoo. As described in Attachment B, SNWA's interdependent actions are not expected to result in take of yellow-billed cuckoo and may be beneficial by improving hydrological conditions that support species' habitat.

R.3.3.3 Yuma Clapper Rail

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the Yuma clapper rail. The Yuma clapper rail is only present along the Muddy and Virgin River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to result in take of the rail and may benefit the rail by improving hydrological conditions that support its habitat.

R.3.3.4 Moapa Dace

The proposed action in combination with SNWA's interdependent action is not expected to have any effects on the Moapa dace. The Moapa dace is only present in the Warm Springs area along the Muddy River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to affect the dace or its habitat.

R.3.3.5 Woundfin and Virgin River Chub

The proposed action in combination with SNWA's interdependent action may affect, but is not likely to adversely affect the woundfin or Virgin River chub. The woundfin and Virgin River chub are only present along the Virgin River portion of the action area and, as described in Attachment B, SNWA's interdependent actions are not expected to result in take of these species nor appreciably diminish the value of critical habitat designated along the Virgin River for woundfin and Virgin River chub conservation or the value of critical habitat for survival of these species. Furthermore, these independent actions may benefit the woundfin and Virgin River chub by improving hydrological conditions that support their habitat.

R.3.3.6 Humpback Chub

Based on the following analysis, Reclamation has determined there is the possibility of take of individual humpback chub through increased competition, predation, and parasitism, and therefore Reclamation has concluded the proposed action may affect and is likely to adversely affect the humpback chub.

Humpback chub occur in the Colorado River below Glen Canyon Dam and in the Little Colorado River that is tributary to this river segment. None are known to be present in Lake Powell, and the species is not found in the Virgin or Muddy Rivers.

The proposed action could alter sediment transport, water temperature, and daily flows in the Colorado River below Glen Canyon Dam relative to baseline conditions. Sediment transport is directly related to river flow (Table R-6). The proposed action could result in annual releases from Glen Canyon Dam of less than 8.23 mafy approximately 9.7 percent more frequently than under baseline conditions, which would reduce the transport of sand out of the river and into Lake Mead (Attachment C, Table BA-4). During those times, sediment transport out of the river and into Lake Mead would be reduced per the relationship described in Table R-6. Annual release rates above the minimum objective release of 8.23 maf could occur with a frequency about 17 percent higher than under baseline conditions (Attachment C, Table BA-4). These higher releases would transport more sediment out of the river. The probability of releases above 9 mafy (9.01 mafy to above 16 mafy) is very similar under baseline conditions and the proposed action (differ by approximately 0.5 percent) and thus the effect on sediment transport would be very similar.

The quantitative effects of these changes in release rates on instream habitat suitability for humpback chub are difficult to predict. Goeking et al. 2003 noted considerable temporal variability in both backwater number and area with river discharge, and also variability among sights 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 the welfare of the fish very difficult. On the other hand, Stevens and Hoffnagle found that both backwater number and area decrease at flows above 10,000 cfs, and similar findings were documented by McGuinn-Robbins (1997). These relationships, together with more frequent releases above 8.23 maf under the proposed action may act reduce backwater availability during certain years, especially during the months of August and September when those habitats are most critical to the fish. High releases along with increased flow fluctuations may exacerbate this problem.

For the baseline and proposed action, modeling results indicate that monthly average water temperatures in the Colorado River at Lees Ferry would be the same and would be below the requirements for humpback chub spawning and egg incubation under the 10th, 50th, and 90th percentile conditions (Attachment C, Table BA-5) during the spawning season of March through July. Near the confluence of the Little Colorado River, the average water temperatures could meet or exceed minimum spawning, egg incubation and growth requirements during July (end of spawning season) only under the 10th percentile conditions for both baseline and the proposed action. The average water temperature near the Little Colorado River would be less than 1ºC warmer for the proposed action than for the baseline in most months (Attachment C, Table BA-6), which may benefit humpback chub during 10th percentile years when life stage minimum temperature thresholds are exceeded; this slight increase may also help minimize thermal shock to young-of-year humpbach chub entering the main channel from the LCR. At the confluence of Diamond Creek, average water temperatures could be suitable for humpback chub spawning, egg incubation and growth in

June and July under baseline 10th percentile conditions and in May through July under proposed action 10th percentile conditions. The average temperatures at the Diamond Creek confluence could be up to 1.4ºC warmer for the proposed action than for the baseline in most months, which may benefit humpback chub during 10th percentile years when optimal spawning, incubation and growth temperatures are attained earlier in the year. However, under the proposed action the maximum temperature for growth (22° C) may be approached more frequently during 10th percentile years, which may result in impeded growth compared to the no action.

For the 50th percentile conditions, average temperatures at Diamond Creek could be less than 1ºC warmer for the proposed action than for the baseline in April through August, and spawning could occur one month earlier (June), compared to the baseline. This would be beneficial to humpback chub as minimum incubation and growth temperatures would also be met earlier in the year. For the 90th percentile conditions, average temperatures at Diamond Creek would be the same for the proposed action and the baseline (Attachment C, Table BA-7). The slightly warmer water temperatures in the river from the confluence of the Little Colorado River to Diamond Creek in some months under the proposed action could also increase growth of humpback chubs and their food base organisms, a benefit to the species.

Under 50th percentile conditions, average monthly temperatures for the proposed action would be less than 1.5ºC lower than under baseline conditions near the Little Colorado River confluence and less than 1.8ºC lower than baseline conditions at Diamond Creek from September through March (Attachment C, Tables BA-6 and BA-7). The temperatures would be the same under baseline and proposed action conditions at Lees Ferry (Attachment C, Table BA-5). Near the Little Colorado River, the average monthly water temperatures during these months would be less than that required for growth (16ºC) of the humpback chub under both baseline and proposed action conditions (Attachment C, Table BA-6). At Diamond Creek, the average monthly water temperature for the proposed action in September would be 0.8 ºC cooler than for baseline but would remain above the minimum growth temperature (Attachment C, Table BA-7). From October through March, average monthly water temperatures would be below the minimum growth temperature under both baseline and proposed action conditions. Thus, the slightly lower water temperatures under the proposed action would adversely affect growth of the humpback chub to about the same extent as the no action alternative.

The slightly warmer water temperatures under the proposed action relative to baseline conditions also could 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 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 striped bass, and channel catfish increase in abundance below RM 160 (Gloss et al. 2005). Also present in low numbers are black bullhead, yellow bullhead, green sunfish (GCMRC, unpublished).

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 inflow to Lake Mead include channel catfish, walleye, striped bass, and largemouth bass. Smallmouth bass are rare in the river, inflow area, and Lake Mead. Temperature requirements for these species are shown in Table R-7. 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 under 10th percentile conditions (Attachment C, Tables BA-5 through BA-7). Temperatures under the 50th and 90th percentiles would provide no benefits to nonnative fish.

Since many nonnative fish prey on native fish, the potentially increased number and/or feeding activity of nonnative fish at 10th percentile temperatures could adversely affect the humpback chub in this reach. However, many species of non-native fish are already present in this reach and the infrequent, slightly warmer 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 19ºC for extended periods in the summer (Moyle 2002). The proposed action would not increase average monthly water temperatures to above 19ºC (based on modeling results) near the Little Colorado River under any conditions (Attachment C, Table BA-6). Near Diamond Creek, average water temperatures are above 19ºC in July through September under baseline conditions, and the proposed action could increase these average temperatures by about 1ºC and extend the duration of warmer temperatures by a few weeks (Attachment C, Table BA-7). Thus, the preferred action would be unlikely to result in a population increase for smallmouth bass in the Colorado River between Glen Canyon Dam and Lake Mead.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchorworm (*Lernaea cyprinacea*) in the mainstream Colorado River in some years. Currently, these nonnative fish parasites are found primarily in fish in the Little Colorado River and other side tributaries, and they mostly affect native fish. Under baseline conditions, these parasites are less likely to infect fish in the Colorado River because water temperatures are less than optimal for these parasites. 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. Glen Canyon Dam releases made when Lake Powell water levels are at the higher 50th and 90th percentile elevations result in approximately the same to cooler downstream temperatures that are always below 20°C for the baseline and proposed action (Attachment C, Tables BA-5 through BA-7).

Table R-7
Nonnative Fish Temperature Requirements (Minimum-Maximum)

Common and Scientific Name	Spawning (ºC)	Incubation (ºC)	Growth (ºC)
Black bullhead *Ameiusus melas*	19-22	21-24	20-22
Channel catfish *Ictalurus punctatus*	21-29	20-30	21-30
Brown trout *Salmo trutta*	7-14	8-20	12-20
Rainbow trout *Oncorhynchus mykiss*	8-13	7-15	12-21
Common carp *Cyprinus carpio*	18-30	20-30	15-30
Fathead minnow *Pimephales promelas*	16-30	16-29	18-27
Red shiner *Cyprinella lutrensis*	15-30	15-25	18-28
Mosquitofish *Gambusia affinis*	18-30	20-24	14-28
Plains killifish *Fundulus zebrinus*	20-30	20-30	20-30
Walleye *Stizostedion vitreum*	4-13	4-14	18-23
Striped bass *Morone saxatilis*	14-24	16-26	23-30
Green sunfish *Lepomis cyanellus*	19-31	19-24	26-31
Largemouth bass *Micropterus salmoides*	16-20	16-20	16-30
Smallmouth bass *Micropterus dolomieu*	13-18	14-18	20-26
Endangered Fish Temperature Requirements (Minimum-Maximum)			
Bonytail *Gila elegans*	18-22	18-28	18-24
Colorado pikeminnow *Ptychocheilus lucius*	16-24	19-25	18-23
Razorback sucker *Xyrauchen texanus*	12-22	14-25	18-24
Humpback chub *Gila cypha*	16-22	16-27	16-22

Source: Valdez 2006

Reduced annual releases from Glen Canyon Dam under the proposed action could also result in a reduction 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 baseline conditions is approximately 6,000 to 8,000 cfs with the wider range in July, August, December, and January (Attachment C, Tables BA-2 and BA-3). 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 (Attachment C, Tables BA-1 through BA-3). This lower potential flow range would be unlikely to occur under baseline conditions because there is a low probability 0.05 percent) of an annual release of 7.48 mafy and would have about an approximately 8 percent probability of occurring for the proposed action (Attachment C, Table BA-4). For release rates between 9.0 mafy and over 16 mafy, the probability of such releases under baseline conditions and the proposed action are very similar (differ by approximately 0.5 percent). Therefore, the flow effects of annual releases above 9 mafy on daily flows is very similar under baseline conditions and the proposed action. Because the probability of annual releases above 9 mafy is very similar under baseline and the proposed action, and the frequency of the lower range of potential hourly flows when the annual release is lower than 8.23 mafy is low, effects on habitat that could be used by humpback chubs from changes in the potential range of hourly flows would be negligible (Attachment C, Tables BA-2 through BA-4), unless equalization under volumes > 8.23 maf (17 percent greater chance of that) result in higher fluctuations during the months of August and September, impacts to backwater habitat availability and temperatures could be significant. Humpback chub young-of-year are typically abundant in the mainchannel during those months, so habitat availability may be an issue.

The level of take that could occur from the proposed action relative to that under baseline conditions, particularly due to potential beneficial effects on nonnative fish that result in competition with or predation on humpback chubs, cannot be quantified but is expected to be none in most years. However, a small level of take of individuals could occur in a few years from warmer 10th percentile releases from Glen Canyon Dam, because of these temperatures benefiting non-native fish predators. The small amount of take, if it occurs, is not expected to cause a change in the population of the humpback chub. The benefits of warmer water on populations of the humpback chub could at least partially offset the take due to increased predation by nonnative fish.

The possible effects of the proposed action on the habitat (and its components including water temperature and quality, flows, etc.) as described above would be minor. Consequently, the possibility of impacts on critical habitat resulting from the proposed action is not expected to appreciably diminish the value of critical habitat for humpback chub conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species

R.3.3.7 Razorback Sucker

Based on the following analysis, Reclamation has determined the proposed action may affect, but is not likely to adversely affect the razorback sucker. Razorback sucker can occur at the riverine inflow areas to Lake Powell but are considered rare here. Razorback sucker have not been found in the Colorado River between Glen Canyon Dam and Lake Mead for over 15 years although a few individuals could still be present. Razorback sucker are not found in the Virgin or Muddy Rivers.

When Lake Powell is below elevation 3,660 feet msl, a waterfall exists at the San Juan River inflow at RM 0.6. This waterfall serves as a fish barrier for the upstream movement of non-native fish into the San Juan River from Lake Powell. The proposed action is expected to result in a greater probability that Lake Powell elevations could be at or below 3,660 feet msl

(Appendix C, Figures BA-1 through BA-5) compared to baseline conditions. Accordingly, the waterfall could be established more often under the proposed action than under baseline conditions in the future, providing a minimal potential benefit to razorback sucker in the San Juan River upstream of Lake Powell. However, this same waterfall would prevent Razorback sucker that wash down into Lake Powell from moving back up into the San Juan River. Adults that are trapped this way could reside at the inflows, though juveniles are more likely to be eaten by striped bass and other piscivorous fish that reside in Lake Powell. However, juveniles that end up in Lake Powell when the waterfall is not present are also likely to be eaten. Therefore, the level of razorback sucker predation due to this waterfall that may be associated with the proposed action is expected to be the same as under baseline conditions. Consequently, compared to baseline conditions the proposed action may affect, but is not likely to adversely affect the razorback sucker.

The lower Lake Powell water levels under shortage conditions would increase the amount of riverine habitat in the Dirty Devil arm of Lake Powell and thus provide more suitable habitat for this species. The proposed action would result in Lake Powell lake levels that are up to 16 feet lower than under baseline conditions at the 50th percentile.

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 could result in annual releases from Glen Canyon Dam of less than 8.23 mafy approximately 9.7 percent more frequently than under baseline conditions, which would reduce the transport of sand out of the river and into Lake Mead (as described in Section 3.3.6 of the BA for the Humpback Chub). During those times, sediment transport out of the river and into Lake Mead would be reduced (Table R-6). Annual release rates above the minimum objective release could occur with a frequency about 17 percent higher than under baseline conditions. These higher releases would transport more sediment out of the river. The probability of releases above 9 mafy (9.01 mafy to above 16 mafy) is very similar under baseline and the proposed action (differ by approximately 0.5 percent) and thus the effect on sediment transport would be very similar (Attachment C, Table BA-4). The effects of these changes in release rates on habitat suitability for razorback sucker are unknown.

Changes in release volumes also could increase water temperatures in the river when Lake Powell levels are low enough that warmer water would be released. Modeling results show that the increases would occur primarily at the 10th percentile lake levels and that the increase in average temperature would be about 1ºC in spring and summer (Attachment C, Tables BA-5 through BA-7). For the 50th percentile Lake Powell level, average water temperatures would change very little during most of the year with slightly colder temperatures in the fall. At the 90th percentile Lake Powell level, temperatures would be similar to baseline conditions. The slight warming in spring to summer would provide little or no benefit for razorback spawning because the time when suitable spawning temperatures are present would be changed very little (a few weeks at the most), but it could increase growth. The slightly warmer water temperature in the river near Lake Mead at the 10^{th} percentile level could result in some individual razorbacks moving from Lake Mead into the river upstream, at least during the spring to summer of those years when Lake Powell is at the 10th percentile elevation.

As described for the humpback chub above, average monthly water temperatures would be slightly lower for the proposed action than for the baseline from September through March under 50th percentile conditions near the confluence of the Little Colorado River and Diamond Creek (Attachment C, Tables BA-6 and BA-7). Temperatures under both the baseline and proposed action, however, would be below that required for growth of the razorback sucker (18 ºC) during all of these months, and the slightly lower temperatures under the proposed action would not adversely affect growth of this species.

Warmer water temperatures under the proposed action relative to baseline conditions also would have the potential to benefit nonnative fish species that compete with or prey upon razorback suckers by allowing earlier reproduction and increased growth in those years when such temperature increases occur. Furthermore, the small increase in average temperature in some years has a low potential to increase movement of nonnative species into the river from Lake Mead and from tributaries that provide inflow to the river in the years that such temperature increases occur (See discussion on Humpback Chub). Although many nonnative fish prey on native fish, the potentially increased number or feeding activity of nonnative fish would be unlikely to adversely affect the razorback suckers in this reach because the few that may be present are adults that would be too large for most nonnative fish to eat. Many species of non-native fish species are already present in this reach and the infrequent, slightly warmer temperatures are unlikely to increase their long-term abundance or species composition.

Warmer river temperatures could increase the potential for expansion of the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchorworm (*Lernaea cyprinacea*) in the mainstream Colorado River in some years as described for the humpback chub. Under baseline conditions, these parasites are less likely to infect fish in the Colorado River because average water temperatures are less than optimal for these parasites. 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 potential temperatures exceed 20 ºC. This could adversely affect the razorback sucker. The level of effect is unknown but expected to 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. Glen Canyon Dam releases made when Lake Powell water levels are at the higher 50th and 90th percentile elevations result in approximately the same to cooler downstream average river temperatures that are always below 20°C for the baseline and proposed action (Attachment C. Tables BA-5 through BA-7).

Reduced annual releases from Glen Canyon Dam under the proposed action could also result in a reduction in the potential range of the hourly maximum and minimum releases from Glen Canyon Dam. At the minimum objective release of 8.23 mafy, the range of potential hourly flows from Glen Canyon dam under baseline conditions is approximately 6,000 to 8,000 cfs with the wider range in July, August, December, and January (Attachment C, Tables BA-2 and BA-3). 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 in April and October through December. This lower potential flow range would be unlikely to occur under baseline conditions because there is a low probability (0.05 percent) of annual release of 7.48 mafy and would have an approximately 8 percent probability of occurring for the proposed action (Attachment C, Table BA-4). For release rates between 9.0 mafy and 16 mafy, the probability of such releases under baseline conditions, and the proposed action are very similar (Attachment C, Table BA-4). Therefore, the flow effects of annual releases above 9 mafy on daily flows is very similar under baseline conditions and the proposed action. Because the probability of annual releases above 9 mafy is very similar under baseline and the proposed action, and the frequency of the lower range of potential hourly flows when the annual release is lower than 8.23 mafy is low, effects on habitat that could be used b razorback sucker from changes to hourly flows would be negligible (Attachment C, Tables BA-2 through BA-4).

The possibility, therefore, of impacts on critical habitat resulting from the proposed action is not expected to appreciably diminish the value of critical habitat for razorback sucker conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species.

R.3.3.8 Colorado Pikeminnow

Based on the analysis below, the proposed action may affect, but is not likely to adversely affect the Colorado pikeminnow.

Colorado pikeminnow can occur at the riverine inflow areas to Lake Powell but are considered rare here as indicated in Section 2.4.6 of this BA. Pikeminnow are extirpated from the Colorado River below Glen Canyon Dam and, as a result, the proposed action would not affect the species in this river reach. The species is also not present in the Virgin or Muddy Rivers.

In general, the lacustrine environment of Lake Powell is less than ideal habitat for Colorado pikeminnow. The proposed action may provide a minor benefit to pikeminnow upstream of Lake Powell because it is expected to result in a greater probability that Lake Powell elevations could be at or below 3,660 feet msl in the future than under baseline conditions (Attachment C, Figure BA-1). As indicated above, the waterfall on the San Juan River that can occur at lake levels below 3,660 feet msl, would block the upstream movement of non-native fish from Lake Powell. However, this waterfall also has the potential to block the upstream movement of pikeminnow out of Lake Powell and into the San Juan River. Any adults or juvenile pikeminnows washed into the lake would also be blocked from returning to the river when lake levels are low. Given the rarity of the species in Lake Powell, that the lake serves as less than ideal pikeminnow habitat, and that pikeminnow are similarly affected by Lake Powell conditions and non-native fish interactions when the San Juan waterfall is and is not present, take resulting from the proposed action is expected to be the same as under baseline conditions. Consequently, compared to baseline conditions the proposed action is not expected to result in take of Colorado pikeminnow.

Based on the above assessment, the changes in Lake Powell levels between the proposed action and baseline are also not expected to appreciably diminish the value of critical habitat for Colorado pikeminnow conservation, affect the survival or recovery of the species, nor appreciably diminish the value of critical habitat for survival of the species in the Dirty Devil and San Juan river areas in Lake Powell.

R.3.3.9 Bonytail

Based on the analysis below, the proposed action may affect, but is not likely to adversely affect the bonytail.

Bonytail can occur at the riverine inflow areas to Lake Powell but are considered rare here. Bonytail are presumed extirpated from the Colorado River below Glen Canyon Dam to Lake Mead, and thus, the proposed action would not affect the species in that river reach. Bonytail are not present in the Virgin or Muddy Rivers.

In general, the lacustrine environment of Lake Powell is less than ideal habitat for bonytail chub. Given the rarity of the species in Lake Powell and that the lake serves as less than ideal bonytail habitat, take resulting from the proposed action is expected to be the same as under baseline conditions.

R.3.3.10 Kanab Ambersnail

Based on the following analysis, there is potential for take of individual ambersnails and Reclamation has concluded the proposed action may affect and is likely to adversely affect the 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 Vasey's paradise. Kanab ambersnail habitat can be adversely affected by scouring at Colorado River flows exceeding 17,000 cfs. As indicated above, the proposed action will allow Reclamation to release less than 8.23 maf/year under certain 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 annual release of 8.23 (Attachment C, Table BA-3). These lower annual releases have a relatively low probability of occurring under the proposed action (about 0.68 percent for releases between 7.51 to 8.22 maf, 8.11 percent for releases between 7.01 to7.50 maf and 1.26 percent for releases less than or equal to 7.0 maf) (Attachment C, Table BA-4). 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 increase 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 take of the snail 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 and also be higher than baseline. These higher flows (90th percentile) would inundate a larger area of Kanab ambersnail habitat and are best illustrated in the April and May monthly release graphs (Attachment C, Figures BA-9 and BA-10). Conversely, the average monthly flows above 17,000 cfs in other months (e.g., June) are less frequent under the 90th percentile for the proposed action compared to the baseline condition (Attachment C, Figure BA-11). Consequently, the proposed action could result in some level of take greater than under baseline conditions in some months, but any increased incidence in take would not be expected to substantively affect the abundance or distribution of the snail.

R.3.4 Cumulative Effects

Cumulative effects are defined under ESA regulations as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). The action area from Lake Powell to Lake Mead is within the Glen Canyon National Recreation Area, Grand Canyon National Park, and Lake Mead National Recreation Area and is thus is largely under the control of the National Park Service. In addition, the action area includes the westernmost portion of the Navajo Indian Reservation and the northern boundary of the Hualapai Indian Reservation. While portions of these two reservations are within the action area, actions are likely to be subject to consultation through the Bureau of Indian Affairs, as well as the tribal governments. Consequently, it is assumed that activities that would occur in the future would be deemed Federal actions and fall outside the definition of actions causing potential cumulative effects.

R.3.5 Conclusions

Table R-8 on the following page provides the effects conclusions for the species listed in Table R-3. The findings are either "no effect," "may affect, not likely to adversely affect," or "may affect, is likely to adversely affect" and incorporate the conclusions reached in Attachment B where applicable.

Table R-8
Species Effects Conclusions

Common and Scientific Name	ESA Status[1]	No Effect	May Affect: Not Likely to Adversely Affect	May Affect: Likely to Adversely Affect	Will not Modify Designated Critical Habitat	May Modify Designated Critical Habitat[2]
Southwestern willow flycatcher *Empidonax trailii extimus*	E			X		X
Yellow-billed cuckoo *Coccyzus americanus*	C		X			
Yuma clapper rail *Rallus longirostris yumanensis*	E		X			
Moapa dace *Moapa coriacea*	E	X				
Woundfin *Plagopterus argentissimus*	E		X			X
Virgin River Chub *Gila robusta seminuda*	E		X			X
Bonytail *Gila elegans*	E		X			
Humpback chub *Gila cypha*	E			X		X
Razorback sucker *Xyrauchen texanus*	E		X			X
Colorado pikeminnow *Ptychocheilus lucius*	E		X			X
Kanab ambersnail *Oxyloma haydeni kanabensis*	E			X		

1 ESA Status:

E = Listed as endangered under the ESA.

C = Candidate species for listing under the ESA.

2 The effects are not expected to appreciable diminish the value of the critical habitat for species conservation.

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Attachment A

Existing ESA Coverage

This attachment to Appendix R is a description of coverage under the Lower Colorado River Multi Species Conservation Program Biological and Conference Opinion for the adoption of Colorado River interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead.

A. Existing ESA Coverage

A.1 Introduction and Approach

The Bureau of Reclamation (Reclamation) proposes to adopt Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead (proposed action). The proposed interim guidelines would remain in effect for determinations to be made through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP).

A Draft Environmental Impact Statement (EIS) for the proposed action was distributed in February, 2007. After consideration of the comments received on the Draft EIS and further analysis[1], Reclamation has identified the operational elements that it intends to incorporate as the Preferred Alternative, herein after referred to as the proposed action, which will be analyzed in the Final EIS.

The four operational elements of the proposed action are the adoption of guidelines that would 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 Decree in the case of *Arizona v. California*, 547 U.S. 150 (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, 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 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

[1] The Draft EIS and comments are available at http://www.usbr.gov/lc/region/programs/strategies.html.

The ESA compliance for the proposed action is comprised of three distinct segments. This approach is being used because three geographical areas of impact are involved, with varying degrees and types of impacts. These geographical areas include:

1) Lake Powell and the Colorado River from Glen Canyon Dam to the upper end of Lake Mead (primarily related to operational element no. 2, coordinated reservoir operations). This segment is not addressed by this transmittal.

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 no. 3, storage and delivery mechanism). This segment is not addressed by this transmittal.

3) The Colorado River from Lake Mead to the Southerly International Boundary with Mexico (primarily related to operational element no. 1, shortage guidelines, operational element no. 2, coordinated reservoir operations, no. 3, storage and delivery mechanism, and operational element no. 4, ISG). These operational elements constitute "covered actions" within the Lower Colorado River Multi-Species Conservation Program (MSCP) and are encompassed within the boundaries of the MSCP planning area.

Each of the three segments of the consultation is prepared as a stand-alone analysis for ease of understanding.

A.2 Detailed Description of Proposed Action

The proposed action is Reclamation's adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead. The action is proposed in order to provide a greater degree of certainty to Colorado River water users and managers of the Colorado River Basin by providing more detailed objective guidelines for the operation of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced during drought and other low reservoir conditions.

The proposed interim guidelines are anticipated to be promulgated in 2008 and would remain in effect for determinations to be made through 2026 and would provide guidance each year in development of the AOP. The interim period, 2008 through 2026, is the period of consultation for the potential effects of the proposed action. After the interim period the operations may revert to the AOP process that is described as the No Action Alternative in the EIS.

The proposed action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action. The interim guidelines would be used by the Secretary to:

- 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 below 7.5 maf (a ‘‘Shortage’’) pursuant to Article II(B)(3) of the Consolidated Decree;

- ♦ Define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
- ♦ 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, particularly under drought and low reservoir conditions; and
- ♦ 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 ISG, published in the *Federal Register* on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

The proposed action includes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also provides a mechanism, called Intentionally Created Surplus (ICS), for promoting voluntary water conservation in the Lower Basin.

The formulation of the four operational elements for the proposed action follows:

1) **Shortage Guidelines.** The proposed action provides discrete levels of shortage associated with specific Lake Mead elevations as presented below. The shortages modeled under the proposed action are as follows:

    - When Lake Mead is projected to be below elevation 1,075 feet 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 Basin States, to discuss further measures that may be undertaken consistent with the Law of the River.[2]

[2] The specific outcome of a consultation process to define additional shortages cannot be predicted; therefore, for modeling purposes it was assumed that shortages of 500 kaf would continue to be imposed at Lake Mead elevations below 1,025 feet msl.

The volumes of shortages are expressed as reductions to water users in the United States. However, modeling of the proposed action includes the assumption that Mexico would also incur water delivery reductions proportional to the reductions to United States users in the Lower Basin at the same Lake Mead elevations (equivalently expressed as a water delivery reduction to Mexico of 16.7 percent of the total shortage volume). As such, the total shortage volumes modeled under this alternative are 400, 500, and 600 kaf at elevations 1,075, 1,050, and 1,025 feet msl, respectively, and these reductions of water deliveries are assumed to be applied to the Lower Division states and Mexico.

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 an elevation schedule (Table 1) that would be used in determining when equalization releases would be made.

Table 1
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

When Lake Powell 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 maf per year to equalize its volume with Lake Mead. Otherwise, 8.23 maf is released from Lake Powell.

- **Upper Elevation Balancing.** When Lake Powell is below the elevations stated in Table 1 and is projected to be at or above 3,575 feet msl at the end of the water year, a release in the amount of 8.23 maf from Lake Powell would be made if the projected elevation of Lake Mead is at or above 1,075 feet msl at the end of the water year. If the projected end of water year elevation of Lake Mead is below 1,075 feet msl, the volumes 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.

- **Mid-Elevation Releases.** When Lake Powell elevation is projected to be below 3,575 feet msl and at or above 3,525 feet msl at the end of the water year, a release in the amount of 7.48 maf would be made if the projected end of water year elevation of Lake Mead is at or above 1,025 feet msl. If the projected end of water year elevation of Lake Mead is below 1,025 feet msl, a release of 8.23 maf from Lake Powell would be made.

- **Lower Elevation Balancing.** When the projected end of water year elevation of Lake Powell 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.

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 (retirement of pre-Boulder Canyon Project Act of 1929 water rights on the Virgin and Muddy rivers). The ICS mechanism provides for creating credits for the conserved or imported water and delivering the water at a later date.

   The analysis of potential effects in this assessment includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf. However, it is anticipated that the ICS mechanism will be initially implemented to allow a maximum cumulative amount of ICS credits of up to 2.1 maf.

   The volumes of ICS activity that are assumed for each state and other entities (shown as “Additional Amounts”) are presented in Table 2. 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.[3]

In addition to increasing the flexibility of meeting water use needs from Lake Mead, the ICS mechanism would benefit the system through Lake Mead storage credits. At the time the ICS credits are created, five 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 three 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 2.

Table 2
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 analysis of potential effects includes a maximum cumulative amount of ICS credits that would be available at any one time of up to 4.2 maf.

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

[3] Notwithstanding the lack of an existing mechanism to implement such modeling assumptions, Reclamation utilized these assumptions for a number of reasons, including the following: (1) a larger volume of potential storage in Lake Mead is identified, (2) the maximum potential impacts on river flows below Hoover Dam are identified, (3) the arbitrary assignment of water conservation amounts to entities in the Lower Basin states is avoided, and (4) the modeling impacts of a program of potential future cooperation between the United States and Mexico are identified.

Domestic Surplus Condition during the period 2017 through 2026.[4] 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.

A.3 The Lower Colorado River Multi Species Conservation Program

The MSCP is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the lower Colorado River.

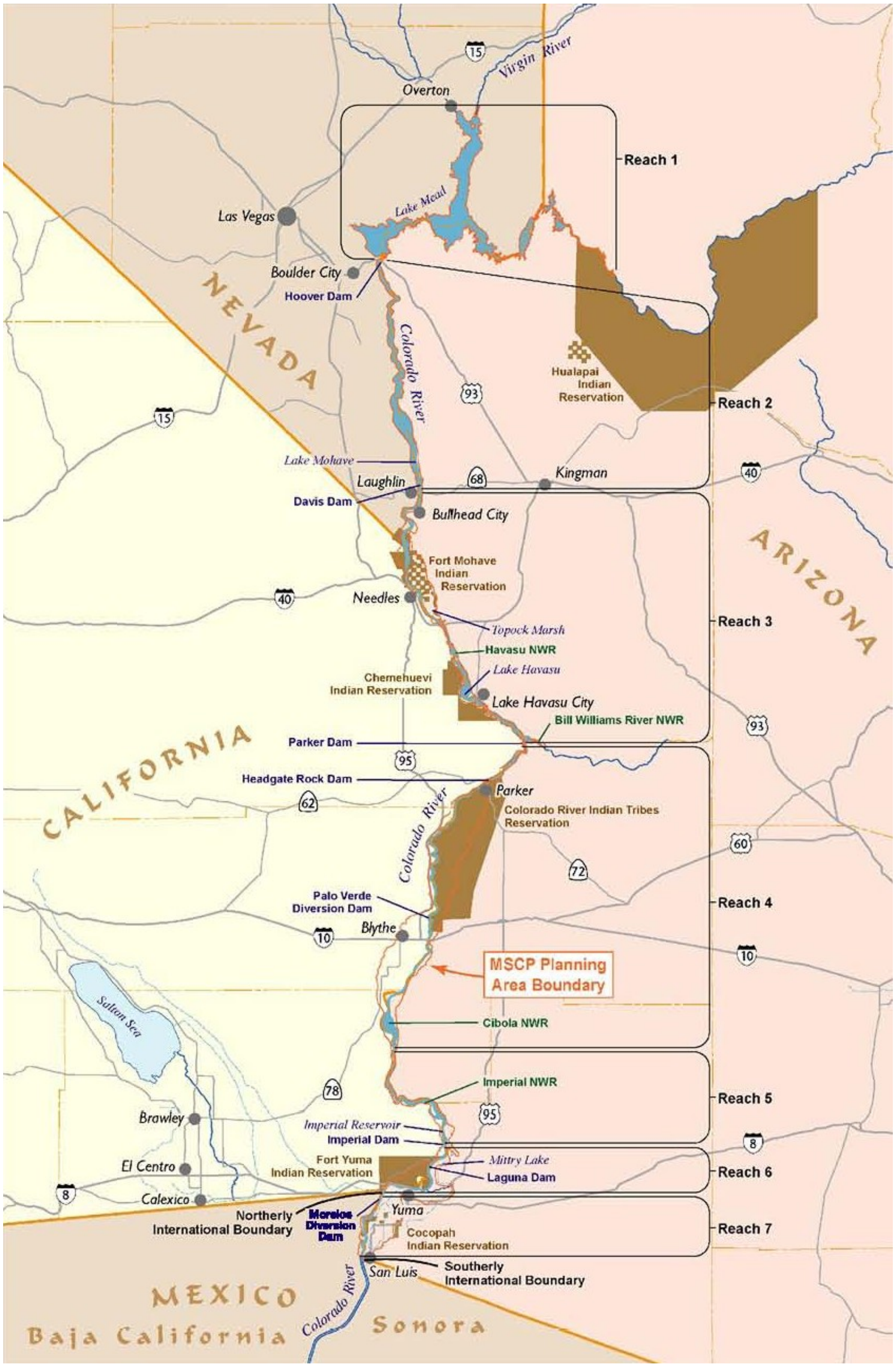
As stated above, the MSCP planning area comprises areas up to and including the full pool elevations of lakes Mead, Mohave, and Havasu and the historical floodplain of the Colorado River from Lake Mead to the Southerly International Boundary. This includes a distance of about 400 river miles. The historical flood plain is defined as all lands that are or have been affected by the meandering or regulated flows of the Colorado River, which historically have been defined by the change in elevation that forms the adjoining uplands (see Figure 1).

Consultation under Section 7 of the ESA has been completed for the MSCP covered actions and activities. During the planning phase for the MSCP, Reclamation included in the covered actions a set of assumptions for future shortage criteria and the extension of the ISG as part of the effects modeling for the project area. These assumptions provided for future coverage of the proposed action under the MSCP if the specific features of the proposed action fell within the assumptions included in the MSCP analysis. The MSCP Final Biological Assessment (BA) was completed on December 17, 2004. The Biological and Conference Opinion on the Lower Colorado River Multi-Species Conservation Program, Arizona, California, and Nevada (BCO) was completed on March 4, 2005. The BCO determined that, with the ranges analyzed in the BA, proposed future federal actions including the adoption of shortage criteria, the extension of the ISG, and changes to points of diversion (i.e., due to water transfers and other activities) are not likely to jeopardize the continued existence of listed, candidate, or other covered species, and are not likely to destroy or adversely modify designated or proposed critical habitat.

A complete description including program documents cited in this Attachment, and current status of the MSCP are available at http://www.lcrmscp.gov/.

[4] During 2017 through 2026, the distribution of Domestic Surplus water would be limited as follows: 1) for use by MWD, 250 kafy in addition to the amount of California's basic apportionment available to MWD; 2) for use by SNWA, 100 kafy in addition to the amount of Nevada's basic apportionment available to SNWA; and 3) for use in Arizona, 100 kafy in addition to the amount of Arizona's basic apportionment available to Arizona contractors.

Figure 1
Lower Colorado River MSCP Planning Area and River Reaches



A.4 Existing MSCP Coverage for the Following Identified Elements of the Proposed Action

The flow-related, future federal actions covered under the MSCP include activities that could result in reductions in flows from Hoover Dam to Imperial Dam, changes in reservoir operations of Lake Mead including shortage and surplus determinations, and changes in flows in excess of Mexico's water order reaching Morelos Diversion Dam. Existing coverage of the potential effects on species within the MSCP planning area boundary of the proposed action is determined by comparison with the range of operations analyzed in the MSCP BA and BCO as well as the other relevant MSCP program documents. All modeling assumptions used in the following comparisons for both the proposed action and the No Action Alternative are fully described in Section 4.2 and Appendix A of the Final EIS.

A.4.1 Reductions in Flow

Flow related impacts covered under the MSCP included the impacts of flow reductions below Hoover Dam to Davis Dam (Reach 2, Figure 1) of up to 845 kaf per year (kafy), below Davis Dam to Parker Dam (Reach 3, Figure 1) of up to 860 kafy, and flow reductions of up to 1.574 maf per year below Parker Dam to Imperial Dam (Reach 4 and 5, Figure 1). For the proposed action, changes in points of diversion due to conservation activities (i.e., the creation of ICS credits) and shortage conditions would contribute to potential flow reductions.

Figures 2, 3, and 4 display the probability of flow reductions for Reaches 2, 3, 4, and 5 for the duration of the proposed action. For comparison purposes, the results for the No Action Alternative used in the Final EIS are also shown. These figures show that the proposed action will not exceed the flow reductions analyzed and are within the range of the reductions anticipated under the MSCP.

Flow reductions result in lower water surface elevations in the main channel of the river and its associated backwaters. The reduced water surface elevations also result in lower groundwater levels. The river stage along the river is correlated directly with discharge.

Therefore, because the discharge below each of the dams is not expected to be reduced below that which the MSCP has coverage, the range of effects resulting from the proposed action is covered by the MSCP BCO.

Figure 2
Hoover to Davis Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 845 kaf

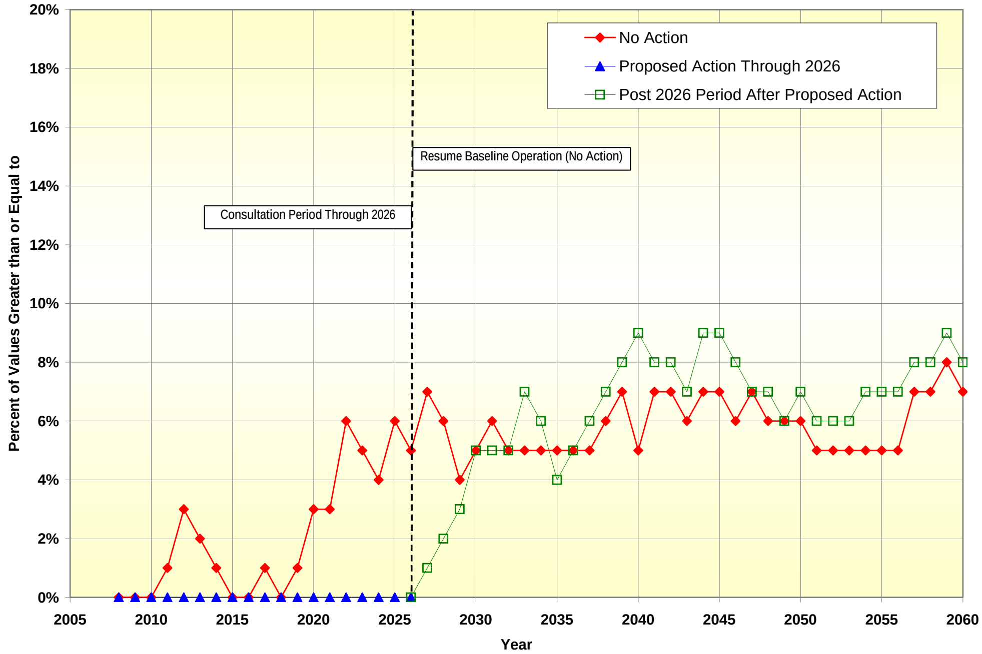


Figure 3
June 2007 24-Month Study Initial Conditions Davis to Parker Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 860 kaf

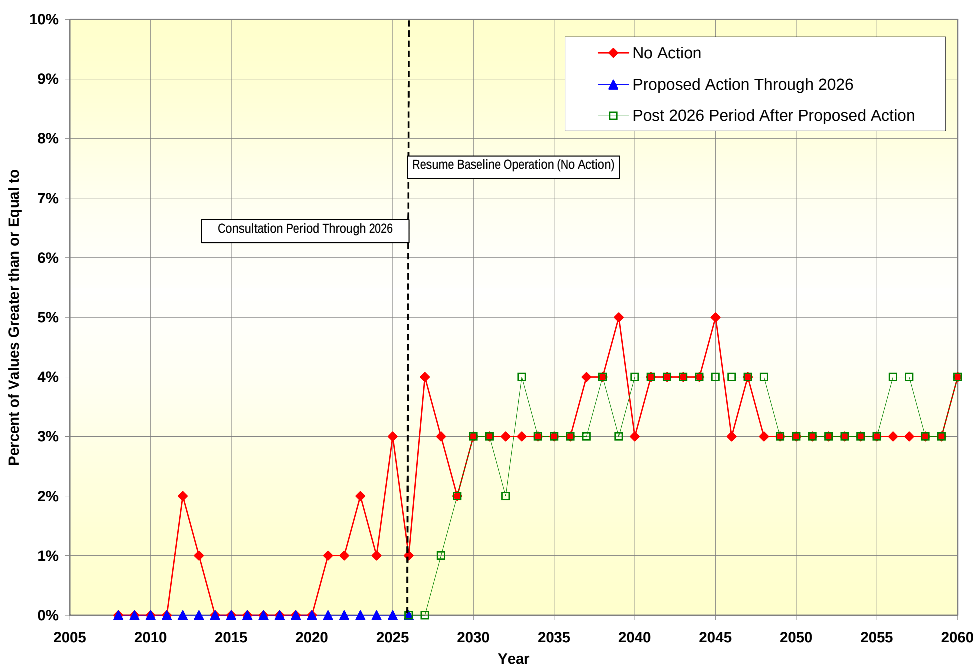
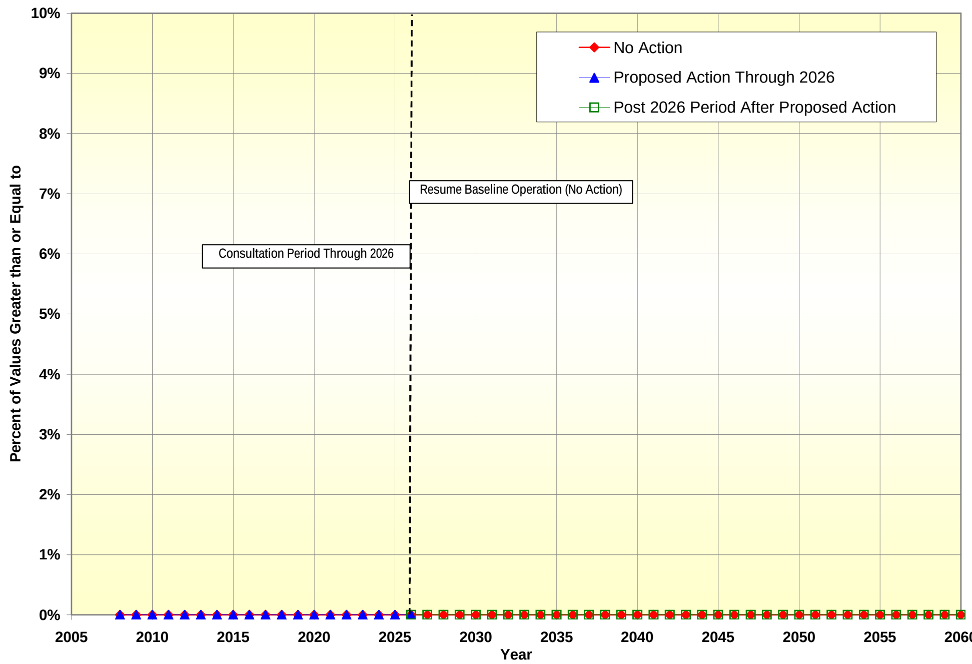


Figure 4
Parker to Imperial Reach Reductions
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to 1574 kaf



A.4.2 Reservoir Operations

The proposed action includes the imposition of discrete levels of shortage volumes associated with Lake Mead reservoir elevations and extending and modifying the ISG through 2026, the effects of which were analyzed in and accordingly are covered by the MSCP BCO and described below.

The MSCP analysis assumed that under a first level shortage, elevation 1,050 msl would be protected with an approximate 80 percent probability. In a given year, a shortage that ranges from approximately 350 to 500 kaf would be imposed when the projected January 1 Lake Mead elevation is below a trigger elevation for that year. Under a second level shortage, shortages would be imposed by amounts required to maintain the Lake Mead water elevation at or above 950 feet msl. In comparison, the proposed action includes shortage reductions to United States water users of 333, 417, and 500 kaf imposed at elevations 1,075, 1,050, and 1,025 feet msl, respectively. Additionally, the modeling assumed a 500 kaf shortage to United States users was imposed at or below elevation 1,025 feet msl. As previously mentioned, modeling of the proposed action includes the assumption that Mexico would also incur water delivery reductions proportional to reductions to Untied States users at the same Lake Mead elevations, resulting in total water delivery reductions of 400, 500, and 600 kaf at elevations 1,075, 1,050, and 1,025 feet msl, respectively.

The MSCP analyzed and covered the extension of the ISG through 2051. Since the proposed Lower Basin shortage guidelines are anticipated to be implemented through 2026, extending the ISG establishes an operational strategy for the full range of reservoir operations - high and low - at Lake Mead. It should also be noted that the extended ISG have been modified by eliminating the Partial Domestic Surplus Condition in 2008 and limiting the amount of water available under a 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.

Although the proposed action proposes reductions in deliveries based on specific reservoir elevations (as compared to the assumptions in the MSCP analysis that assume absolute protection of elevation 950 feet msl), analysis of the proposed action shows that Lake Mead elevations are within the range of effects analyzed in the MSCP BCO. Figure 5 shows the probability of Lake Mead elevations less than 1,050 feet msl during the interim period. Figure 6 shows the probability that Lake Mead elevation will be less than 950 feet msl during the interim period. For comparison purposes, the No Action Alternative from the Final EIS has been displayed in Figures 5 and 6.

Figure 5
Lake Mead End-of-December Water Elevations
Percent of Values Less than or Equal to Elevation 1,050 feet msl

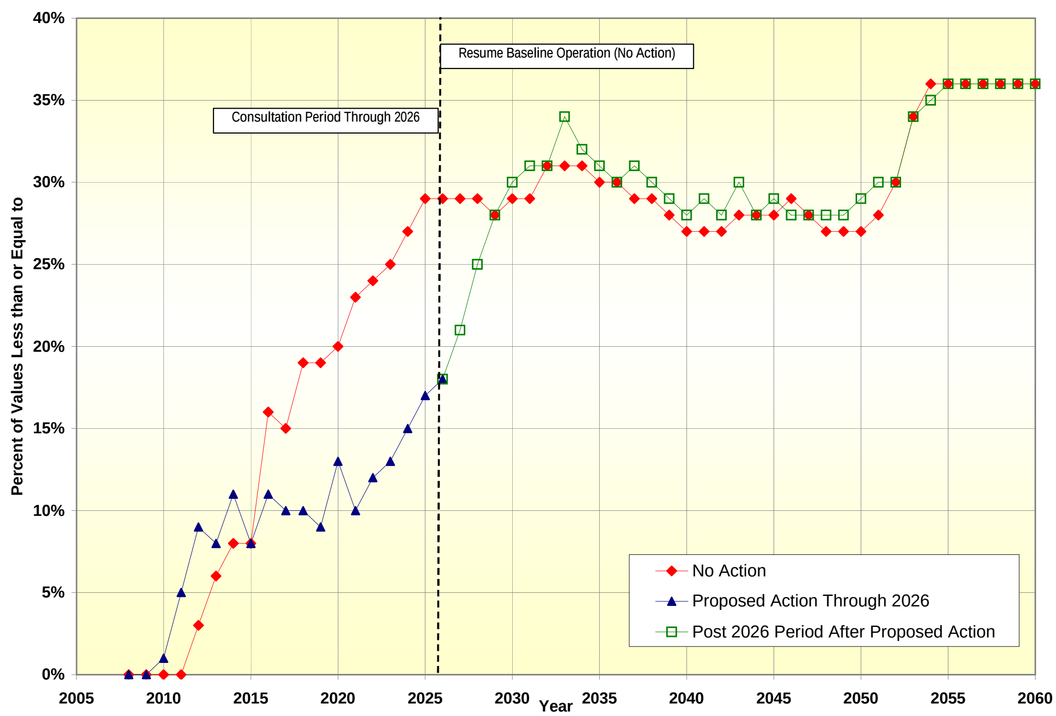
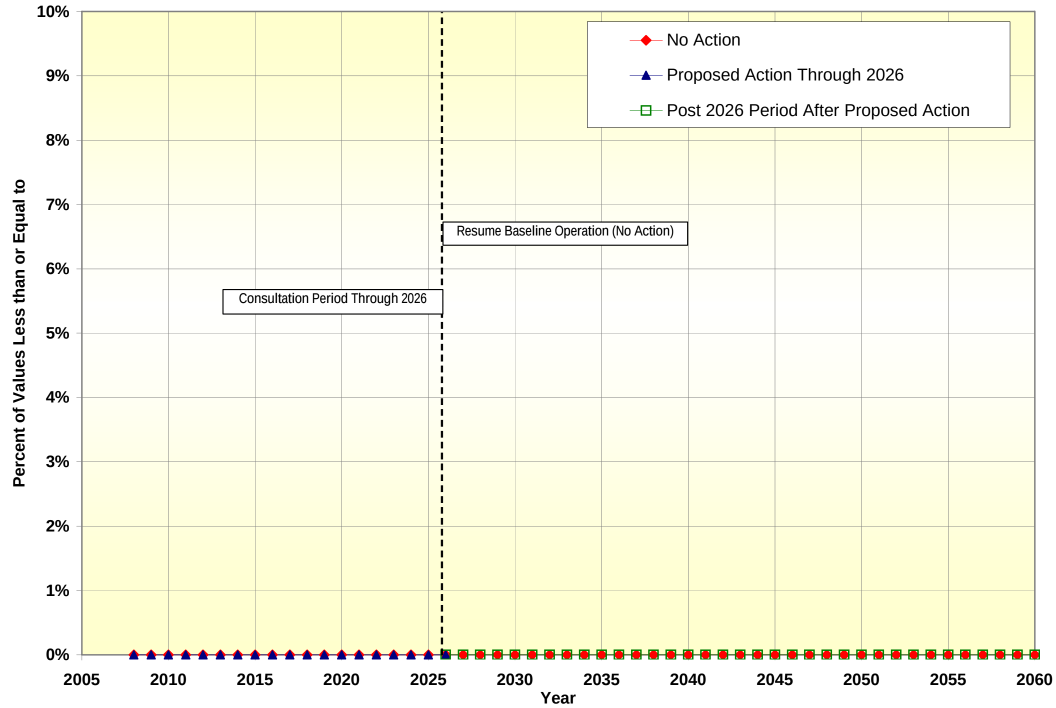


Figure 6
Lake Mead End-of-December Water Elevations
Percent of Values Less than or Equal to Elevation 950 feet msl

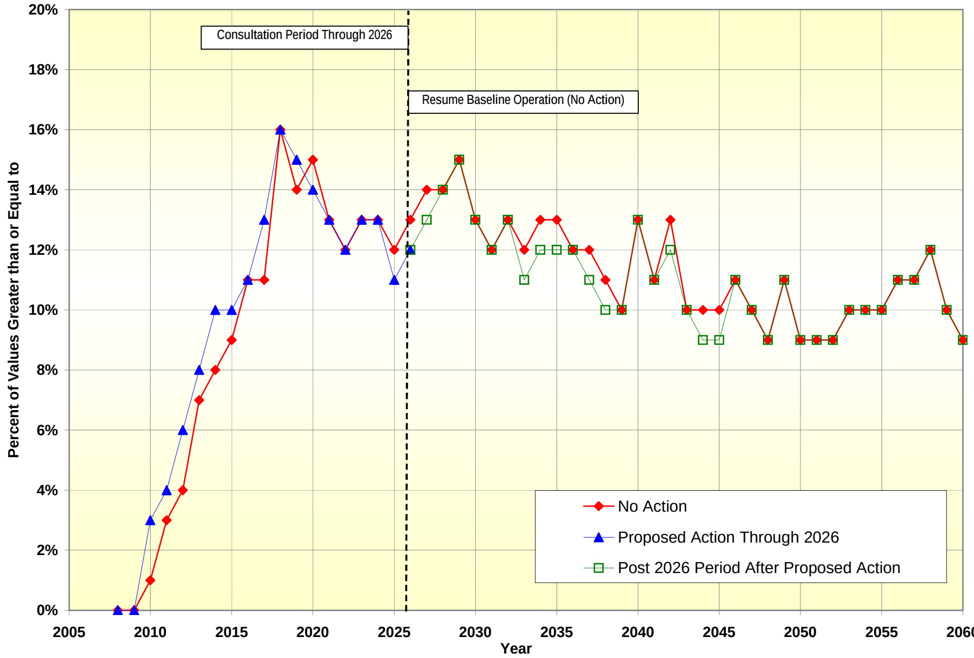


A.4.3 Effects of Proposed Action on Beneficial Flows past Morelos Diversion Dam - Limitrophe Reach

The MSCP BCO included the effects of the covered actions and activities on beneficial flows arriving at Morelos Diversion Dam.

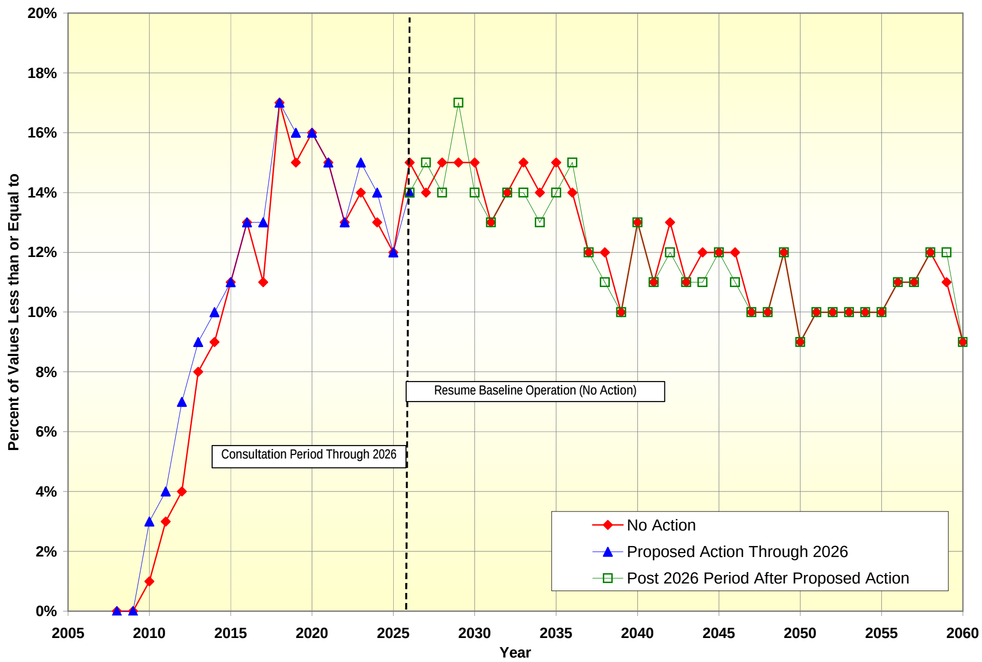
Beneficial flows were defined as flows exceeding 250 kafy in excess of Mexico's water order arriving at Morelos Diversion Dam (MSCP Appendix L). Other ongoing activities including the proposed lower Colorado River Drop 2 Storage Reservoir Project and the Laguna Reservoir Restoration Project would not affect flows arriving at Morelos Diversion Dam exceeding 250 kafy. The MSCP analysis determined that there would be no significant effects on beneficial flows below Morelos Diversion Dam as a result of MSCP covered actions and activities. Figure 7 presents a comparison of the probability of beneficial flows exceeding 250 kafy for the No Action Alternative and the proposed action. Under the proposed action there is a slight increase in probability of beneficial flows over the consultation period (Figure 7) as compared to the No Action Alternative from the Final EIS due primarily to the conservation element of the proposed action. However, this increase is not deemed to be a significant change in the probability of these beneficial flows.

Figure 7
Excess Flows Downstream of Morelos Diversion Dam
Comparison of Preferred Alternative to No Action Alternative
Probability of Values Greater than or Equal to 250 kaf



The probabilities of any excess flows of any magnitude arriving at Morelos Diversion Dam were also analyzed. These probabilities showed the same trend in flows of greater than 250 kafy arriving at Morelos Diversion Dam in excess of Mexico's water order (Figure 8).

Figure 8
Excess Flows Downstream of Morelos Diversion Dam
Comparison of Preferred Alternative to No Action Alternative
Probability of Occurrence



It is noted that with the exception of extremely high mainstream Colorado River flows from 1983 to 1985, the beneficial flows arriving at Morelos Diversion Dam since the 1970s have largely been a result of Gila River flows. Gila River flows are unaffected by the proposed action. Tributary inflows from the Gila River to the mainstream are very sporadic, occur very seldom, and when they do, are typically of high magnitude. These flows were not included in the analysis of excess flows arriving at Morelos Diversion Dam prepared for the MSCP or in the analysis presented herein. Therefore, the timing and benefits from those flows reaching Morelos Diversion Dam are not considered in this analysis.

A.5 Conclusion

The MSCP BCO stated, "At the time the shortage guidelines are adopted, Reclamation will complete an analysis to determine if the effects are within the range of effects analyzed in the BA. If they are not, additional consultation may be required." Based on the analysis herein, Reclamation concludes that the potential effects of the proposed action that fall within the MSCP BCO planning area boundary were covered in the previous consultation for the MSCP, and no significant new information exists that would require additional consultation for the proposed action.

Attachment B

Evaluation of Interrelated/Interdependent Effects of Tributary Conservation Intentionally Created Surplus Projects

This attachment to Appendix R describes the analysis of the effects of the interrelated/interdependent action of Southern Nevada Water Authority's proposed Virgin River and Muddy River tributary conservation Intentionally Created Surplus (ICS) projects.

B. Evaluation of Interrelated/Interdependent Effects of Tributary Conservation Intentionally Created Surplus Projects

B.1 Overview

Between 2000 and 2007, the Colorado River experienced the worst drought in approximately 100 years of recorded history. Currently, the Bureau of Reclamation (Reclamation) does not have specific guidelines to address the operation of Lake Powell and Lake Mead under drought and low reservoir conditions. To address this situation, the Secretary of the Interior (Secretary), acting through Reclamation, proposes to adopt interim Colorado River guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead (proposed federal action). The federal action is proposed in order to provide a greater degree of certainty to Colorado River water users and managers of the Colorado River Basin by providing more detailed objective guidelines for the operation of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced during drought and other low reservoir conditions.

The Preferred Alternative, the proposed federal action, identified during development of the Environmental Impact Statement (EIS) includes the adoption of a mechanism to encourage and account for augmentation and conservation of water supplies, e.g., fallowing of land, canal lining and other system efficiency improvements, and introduction of tributary and non-system water in the Lower Basin. The mechanism, referred to as Intentionally Created Surplus (ICS), provides for creating credits for the conserved or imported water and delivering the water at a later date. Tributary conservation is a form of ICS where water rights on Colorado River tributaries within the Lower Basin that have been used for a significant period of years and were created prior to Congress' adoption of the Boulder Canyon Project Act of 1929 (BCPA) could be retired and allowed to flow into the Colorado River mainstream. The Lower Division state or contractor that provides such tributary conservation ICS could then recover the amount of water contributed through tributary conservation ICS for municipal or industrial purposes. Additional modeling details of the ICS mechanism are described in the main body of this Biological Assessment (BA) to which this analysis is attached.

B.1.1 Proposed Action

The proposed federal action to be analyzed in the BA 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, referred to as ICS. The Southern Nevada Water Authority (SNWA) has proposed a project which would be implemented under this component of the proposed federal action. The SNWA proposal would allow pre-BCPA water rights on the Virgin and Muddy Rivers to be retired from their current 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. The SNWA proposal is interrelated/interdependent with the proposed federal adoption of ICS component element of the interim guidelines. Without the proposed federal action, the SNWA proposal for tributary conservation ICS would not go forward as described herein. Specifically, this section of the BA analyzes the interdependent/interrelated effects of the SNWA proposal.

B.1.2 Scope

B.1.2.1 Action Area

The entire action area for the SNWA proposal includes 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 (Figure 1). The action area in the Muddy River begins south of the headwaters at Warm Springs and extends to the confluence of Lake Mead (Figure 2).

B.1.2.2 Scope of Biological Assessment

This section of the BA analyzes the potential effects in the action area of allowing water rights perfected before the effective date of the BCPA to flow down through irrigation company systems and/or the channels and floodplains of the Lower Virgin River and Muddy River to Lake Mead. This portion of the BA does not analyze the potential effects of flow from the Virgin and Muddy Rivers after it enters Lake Mead. Those effects have been analyzed and addressed as part of the Lower Colorado River Multi-Species Conservation Program (MSCP) (USBR 2004a:2-18). Further, the effects of the Lower Basin shortage guidelines and coordinated operations of Lakes Powell and Mead (Lake Powell to Lake Mead) are analyzed in a separate BA to which this analysis is attached.

B.2 Project Description

Water rights on the Virgin and Muddy Rivers that were perfected prior to the effective date of the BCPA (1929) are not subject to provisions in the BCPA and have priority over any water rights appropriated on the Virgin and Muddy Rivers after 1929. The SNWA has been purchasing pre-BCPA water rights on the Virgin and Muddy Rivers since 1997, in an effort to reduce SNWA’s dependence on the Colorado River and develop additional water supplies for Southern Nevada. Water rights historically used for agriculture along these rivers are being voluntarily sold or leased to willing buyers, including buyers not associated with SNWA. Sometimes the water rights are leased back for agricultural use with a provision that at the end of the lease term, the water rights will be retired and allowed to return to the river system. SNWA's purchase and retirement of pre-BCPA water rights will allow for assured flows within the entire Muddy River and the portion of the Virgin River below the Mesquite and Bunkerville Irrigation Companies by using flows that were historically consumptively used off channel by agriculture for the creation of tributary conservation ICS.

Pre-BCPA water rights on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 acre-feet per year (afy) to the

Bunkerville and Mesquite Irrigation Companies. SNWA currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights. On the Muddy River, water rights were decreed in 1920 and that decree allocated the entire flow of the Muddy River. On the Lower Muddy River, the entire flow of the river is diverted by the Muddy Valley Irrigation Company (MVIC) for agricultural use. SNWA currently owns shares in the MVIC representing approximately 7,000 afy of surface water rights and leases approximately 1,000 afy from the LDS Church. The LDS Church lease is for a term of 20 years, with the option to renew the lease for an additional 20 years.

SNWA anticipates acquiring a total of approximately 30,000 afy of pre-BCPA water rights from entities with rights on the Virgin and Muddy Rivers. Approximately one-third of this amount is expected to come from the Virgin River and two-thirds from the Muddy River. This is consistent with the flow volumes that were analyzed in the Final EIS for the shortage and coordinated reservoir operations guidelines and in the analysis for Lake Mead for the MSCP.

As of July 1, 2007, SNWA has acquired water rights from Virgin and Muddy River sources that will yield an average annual water supply of approximately 11,700 afy. The anticipated method of conveying these water supplies through the Virgin and Muddy Rivers to the Overton Arm of Lake Mead is described in Table 1 below. It is anticipated that the additional water supplies to be secured by SNWA (the remainder of the 30,000 afy analyzed here) will be conveyed through the Virgin and Muddy Rivers, via the Overton Arm to Lake Mead through a similar process. SNWA will pursue acquiring water rights on both the Upper Muddy River and on the Lower Muddy River from MVIC; however it is much more likely that the remaining acquisitions on the Muddy River will be from MVIC shareholders. It is unknown at this time from exactly which sources on the Virgin River SNWA will acquire these additional water supplies.

The retired agricultural water rights will be conveyed to Lake Mead via the Overton Arm in one of two fashions. The water will be diverted from the river through its historic point of diversion, flow through irrigation company ditches, and return to the mainstem of the river further downstream if the flow is necessary in the irrigation company ditches to avoid impacts to the irrigation company’s operations or wildlife, such as southwestern willow flycatcher and other bird species that may rely on agricultural returns to support their habitat. This is the proposed operation for waters thus far acquired in the Bunkerville Irrigation Company and MVIC. Alternatively, if the water is not associated with an irrigation company or not required for the purposes described above, it will remain in the mainstem of the river. 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.

Table 1
Example of Conveyance of Tributary Conservation ICS from Virgin and Muddy Rivers to Lake Mead

River	Irrigation Company/Water Right Holder	SNWA's current ownership/leases (approximate values in afy)[a]	SNWA's potential range of acquisitions (approximate values in afy)[b]	SNWA's total future potential ownership/leases (approximate values in afy)[c]	Method of Conveyance
Virgin	Mesquite Irrigation Company	0	0-3,000	Up to 3,000	Remain in river at historic point of diversion
Virgin	Bunkerville Irrigation Company	3,700	4,300 - 6,300	Up to 10,000	Diverted at the historic point of diversion and flow through irrigation company ditches before returning to the river further downstream
Muddy	MVIC	7,000	8,500 - 12,000	Up to 20,000	Diverted at the historic point of diversion and flow through irrigation company ditches before returning to the river further downstream
Muddy	LDS Church Lease	1,000	0 – 1,000	Up to 2,000	Remain in river at the historic point of diversion
Muddy	Other Users	0	0 – 2,500	Up to 2,500	Remain in river at the historic point of diversion

a – Based on conveyance of 11,700 afy water supply secured as of June 1, 2007

b – Based on future potential conveyance of additional 18,300 afy water supply

c - In aggregate supplies will not exceed 30,000 afy however, it is difficult to predict how much water will be purchased from the separate right holder

B.3 Environmental Baseline

B.3.1 Geology and Soils

The project action area is within the Colorado River Regional Flow System (CRRFS) within the southern Great Basin, a sub-province of the Basin and Range Physiographic Province. Land surface elevations in this part of the basin range between approximately 500 feet above mean sea level in the vicinity of Laughlin to approximately 11,900 feet above mean sea level at Charleston Peak in the Spring Mountains. Mountain ranges in this region generally follow northwest southeast trends and the basins are filled with valley-fill sediments, including some volcanic deposits. There are 27 hydrographic areas within the CRRFS. Of these twenty-seven hydrographic areas, five occur within the proposed action area. They are the Lower Meadow Valley Wash, Muddy River Springs Area, California Wash, Lower Moapa Valley (includes the Muddy river), and Virgin River Valley (includes the Virgin River). Other characteristics of the CRRFS include minimal precipitation, intermittent streams, large internal surface drainages, and sparsely distributed springs (BLM 1998).

The CRRFS is located in the southern part of the Great Basin and has an area of about 12,376 square miles (BLM 1998). The region includes part of Clark, Lincoln, Nye and White Pine counties and extends to the south to California, borders the Colorado River to the south and east and extends into the state of Arizona and Utah to the east.

Several periods of regional deposition, uplift, igneous activity and erosion have occurred since the Paleozoic. Thick sequences of marine sedimentary deposits accumulated throughout Paleozoic and Mesozoic times. Approximately 50 million years ago, thick volcanic materials extruded over broad areas of the region, then were uplifted and deformed by faulting.

Soils in the area of the proposed project are classified as "Shallow-Moderately Deep Rocky Gravelly Coarse Textured, Badlands, Shallow-Deep Medium Gravelly Textured, and Shallow-Very Shallow Gravelly Coarse Textured."

B.3.2 Hydrology

B.3.2.1 Lower Virgin River

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 Nevada, Arizona, and Utah. The Virgin River is tributary to the Colorado River and discharges to Lake Mead approximately 60 miles upstream of Hoover Dam. The river begins in Washington County, Utah, at an elevation of approximately 10,000 feet above mean sea level (AMSL), some 150 miles from its mouth.

Flows in the Virgin River are principally influenced by snowmelt in the mountains in southwestern Utah and flooding from summer monsoonal storms. The Littlefield gage is located upstream of the Bunkerville and Mesquite Irrigation Companies. Gage flows are highly variable as seen in Table 2. A maximum discharge of 36,500 cubic feet per second (cfs) was recorded in 2005 and a minimum daily flow of 40 cfs was recorded in 1966. Currently, there is no operational gage below the Bunkerville and Mesquite diversions and their respective agricultural return flows. However, the Halfway Wash Gage was operated from 1977 to 1983 and in 1985. The gage record for this site was reconstructed by Bache et al. in 2006 and shows an annual average flow of 144,800 afy. This is approximately 30,000 afy lower than the flow at the Littlefield Gage (see Table 2).

B.3.2.2 Muddy River

The Muddy River watershed is located in Nevada, immediately northeast of the Las Vegas Valley. The Muddy River discharges to Lake Mead approximately 60 miles upstream of Hoover Dam. Before the construction of the dam and the subsequent flooding of the Colorado and Virgin River Valleys, the Muddy River discharged to the Virgin River, upstream of the confluence of the Virgin and Colorado Rivers.

The highest point in the watershed is Hayford Peak at elevation 9,912 ft AMSL in the Desert National Wildlife Refuge, north of the Las Vegas Valley. The headwaters of the Muddy River's longest tributary are in Lincoln County, at an elevation of approximately 7,300 ft AMSL near the Utah border, nearly 100 miles upstream of Lake Mead. The watershed includes the Pahranagat Valley near Alamo. The Pahranagat Wash flows through the Pahranagat Valley and southward into Coyote Spring Valley, where it joins the Muddy River. The Muddy River continues to the southeast, passing through Arrow Canyon, before it heads southeast, emerging into the Moapa Valley. In its lower reach, the Muddy River passes the towns of Moapa, Glendale (at Interstate-15), Logandale, Glassand, and Overton before discharging to Lake Mead. Glendale is located about 4 miles upstream of the existing Bowman Reservoir, a 4,000 acre-feet surface storage reservoir. Several washes contribute flow to the River along its course, the largest of which is Lower Meadow Valley Wash. Lower Meadow Valley wash joins the river near the intersection of the river and Interstate-15 in Glendale.

Irrigated agriculture is practiced along the flood plain of the lower Muddy River near Moapa and further downstream between Logandale and Overton.

Unlike the Virgin River, which gains the majority of its flow from snow melt and rainfall events, a substantial portion of the Muddy River flows are from spring discharges in the Warm Springs area northwest of Moapa. Because of this, the Muddy River has a more stable base flow and has less variance in annual discharge; however, floods from the Pahranagat River or Lower Meadow Valley Wash can cause large spikes in river flow. The USGS maintains a series of gaging stations on the Muddy River shown in Figure 2. Table 3 summarizes data of three USGS gaging station located along the river.

The Muddy River is generally divided into two portions when addressing surface water rights, the area above Wells Siding Diversion (Upper Muddy River) and the area below (Lower Muddy River). The Muddy River decree allocated between 4,000 and 5,000 afy to users upstream of the Wells Siding Diversion (Upper Muddy River) and the entire remaining flow of the river at the Wells Siding Diversion to the MVIC. SNWA's current ownership on the Upper Muddy River is limited to a 1,000 afy lease from the LDS Church. This water was historically used primarily upstream of the Moapa Gage, but some of the leased water currently flows in the river channel. In recent years, the lands along the Upper Muddy River have been used for livestock, not active farming, resulting in a lower water use than what was historically used and decreed.

Table 2
USGS Gage Record on Virgin River

Virgin River																
USGS ID	Common Name	Period of Record		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
9415000	Littlefield	1930-2006	Mean (af)	9,470	11,426	13,713	15,988	17,829	22,260	24,161	26,380	8,688	6,641	10,638	8,926	**176,422**
			Max (af)	38,372	32,849	76,682	143,094	129,413	110,995	82,420	132,948	66,591	23,429	60,017	43,858	
			Year of Max	2005	1947	1967	2005	1980	1995	1969	2005	1983	1932	1932	1939	
			Min (af)	3,284	6,010	6,826	6,641	5,999	5,251	3,666	3,068	2,785	3,173	3,062	3,172	
			Year of Min	1965	1991	1964	1964	2002	1977	1934	1990	1964	1965	2002	1964	

Table 3
USGS Gage Records on Muddy River

Muddy River																
9416000	Moapa	1913-2006	Mean (af)	2,423	2,476	2,638	2,687	2,438	2,650	2,452	2,515	2,291	2,349	2,411	2,386	**29,727**
			Max (af)	3,806	3,666	3,376	3,407	3,255	3,290	3,118	2,982	2,743	3,474	3,757	5,427	
			Year of Max	1973	1961	1960	1960	1914	1958	1965	1958	1957	1984	1990	1967	
			Min (af)	1,396	1,601	1,722	1,759	1,683	1,753	1,845	1,968	1,750	1,765	1,679	1,506	
			Year of Min	2004	2002	2002	2004	1997	2005	2003	2006	2004	2004	1995	2003	
9419000	Glendale	1950-2006.	Mean (af)	2,275	2,636	2,779	3,241	2,971	3,210	2,517	2,324	1,988	2,017	2,454	2,428	**30,886**
			Max (af)	3,751	12,437	5,989	22,998	12,775	14,574	5,951	2,952	3,011	3,167	8,363	13,390	
			Year of Max	1973	1961	2005	2005	1993	1983	1969	1991	1965	1961	1981	1998	
			Min (af)	1,464	1,773	1,882	1,906	1,777	1,814	1,631	1,734	1,404	1,433	1,482	1,464	
			Year of Min	1997	1996	1997	2004	1997	1989	1989	1997	1997	1990	2001	1996	
9419507	Overton	1998-2004	Mean (af)	965	905	658	547	794	996	899	689	483	603	581	1,113	**9,254**
			Max (af)	1,457	1,262	1,088	756	1,833	1,537	1,214	1,039	821	1,304	1,138	3,344	
			Year of Max	1999	2000	1999	2000	1998	2000	1998	1999	1999	1998	2000	1998	
			Min (af)	595	470	489	439	349	627	514	536	350	313	362	436	
			Year of Min	2002	2002	2002	2004	2004	2003	2002	2003	2004	2004	2004	2001	

In the Lower Muddy River, the surface flows are measured at the Overton Gage which averages approximately 9,000 afy. The Overton Gage is very near the top of full pool elevation in Lake Mead (1,229 ft-AMSL). Therefore, this gage is believed to reflect surface water flows reaching Lake Mead. While there have been no studies confirming irrigation system losses to the alluvium, it is believed that there is water bypassing the Overton gage as underflow from irrigation system losses.

B.3.3 Lower Virgin River Vegetation

The riparian corridor of the Lower Virgin River is comprised of several plant vegetation types. The major types of vegetation include screwbean mesquite (*Prosopis pubescens*), salt cedar (*Tamarisk sp*.), cottonwood/willow (*Populus fremontii, Salix sp.*), arrowweed (*Pluchea sericea*), honey mesquite (*Prosopis glandulosa*), iodine bush (*Allenrolfea occidentalis*), atriplex (*Atriplex sp*), and marsh. Along the edges of the floodplain and transitioning into upland habitats creosote (*Larrea tridentata*) and lycium (*Lycium sp.*) vegetation types occur (Bio-West Inc. 2001:13-18). The main channel of the river is void of vegetation because of recent erosional or depositional events within the floodplain during a January 2005 flooding event and consists of open water islands, sandbars, and gravel bars. Substrate consists of coarse sands and gravels. However, the main channel has begun to re-incise itself and site visits have indicated vegetation has begun to sprout from the re-worked sediments. The following is a brief description of the major vegetation types within the Virgin River floodplain:

- **Salt Cedar –** The exotic, non-native salt cedar vegetation type is the most common throughout the floodplain and a co-dominant species with most of the plant communities. The salt cedar vegetation type is dominated by salt cedar and has a dense to moderately dense canopy depending on the maturity of the population and has very little herbaceous cover in the under story. The salt cedar vegetation type is found throughout the floodplain but most often appears to be associated with a fine sand and clay substrate.

- **Screwbean Mesquite –** The screwbean mesquite vegetation type is composed of almost entirely screwbean mesquite with some degree of salt cedar component or arrowweed, and is also found as a co-dominant within other vegetation types. This plant vegetation type occurs on all substrates within the area except bedrock.

- **Cottonwood/Willow –** The cottonwood/willow vegetation type is dominated by cottonwood and varied species of willow including coyote willow (*Salix exigua*), and gooding’s or black willow (*Salix goodingii*).

- **Arrowweed –** The arrowweed vegetation type is dominated by arrowweed, a low to medium shrub. The arrowweed habitat is low in plant density and diversity. Arrowweed is found throughout the floodplain on sandy sites near or in old channels adjacent to the present river channel. Single stands of arrowweed are uncommon and the populations usually have co-dominant species of screwbean mesquite or are a co-dominant of other communities.

- **Honey Mesquite –** The honey mesquite vegetation type is similar to the screwbean mesquite vegetation type but is very limited within the area.

- **Iodine Bush –** The iodine bush vegetation type is dominated by iodine bush with occurrences of pickleweed (*Salicornia sp.*) and bush seepweed (*Sueda moquinii*). Iodine bush has a limited occurrence in the area. This vegetation type is found on low areas where water slowly evaporates with saline soil conditions.

- **Atriplex –** The atriplex vegetation type is dominated by various atriplex species and when it does occur it is usually a co-dominant of other communities. This vegetation type is found on low areas where water slowly evaporates with saline soil conditions.

- **Marsh –** The marsh vegetation types vary from areas of prolonged inundation or shallow water with dense cover of cattails (*Typha domingensis*) and bulrush (*Scirpus pungens*) to barely vegetated sand bars with young plants of various species just beyond the seedling stage. The marsh vegetation type is common within the area with smaller size communities in the northern portion of the river and larger areas to the south closer to Lake Mead.

- **Creosote –** The creosote vegetation type is dominated by creosote with occurrences of typical upland species found in Mojave Desert scrub habitats. This vegetation type is found along the edge of the flood plain.

- **Lycium –** The lycium vegetation type is dominated by box thorn (*Lycium sp.*) and is found along the edges of the flood plain. This vegetation type and species are also found within the creosote vegetation type.

B.3.4 Muddy River Vegetation

The major types of vegetation on the Muddy River include screwbean mesquite, salt cedar, cottonwood/willow, arrowweed, honey mesquite, atriplex, Acacia (*Acacia sp.*), mulefat (*Baccharis salicifolia*) and marsh (Provencher 2005:86-92). The Muddy River channel is incised in most areas and has been modified for flood control and agricultural purposes. A majority of the river is adjacent to agricultural lands. The only portion of the river that does not have some adjacent agricultural lands is the portion of the river below the Overton Wildlife Management Area. The banks of the river are dominated by tamarisk with pockets of marsh. The following is a brief description of the major vegetation types within the Muddy River floodplain that are not already described above:

- **Acacia –** The Acacia vegetation type is monotypic being dominated by Acacia and has very limited occurrence within the floodplain. This vegetation type is also a co-dominant within saltcedar and Atriplex vegetation types.

- **Mulefat –** The mulefat vegetation type is monotypic dominated by mulefat and has very limited occurrence in the floodplain. This vegetation type is also a co dominant within the saltcedar vegetation type.

B.3.5 Wildlife

B.3.5.1 Riparian and Aquatic Obligate Wildlife

Lower Virgin River Bird Species. The various riparian habitats along the floodplain of the Lower Virgin River support a variety of wildlife species. The riparian habitats are important sources of water, cover and foraging for many species. Probably the most diverse wildlife that uses this habitat is bird species. Bird species that occur are both year-round residents and migratory. Some of the birds observed along the Virgin River include cedar waxwing (*Bombycilla cedrorum*), lesser nighthawk (*chordeiles acutipennis*), western kingbird (*Tyrannus verticalis*), white-throated swift (*Aeronautes saxatalis*), yellow warbler (*Dendroica petechia*), and yellow-breasted chat (*Icteria virens*) (Braden 2006:21-28).

Lower Virgin River Endangered Bird Species. Two federally listed bird species are known to occur within the Lower Virgin River: southwestern willow flycatcher (*Empidonax trailli extimus*) and Yuma clapper rail (*Rallus longirostris yumanensis*). The southwestern willow flycatcher was listed as endangered in 1995. The species is known to breed in dense, mesic riparian habitats throughout the Southwest, including the Lower Virgin River. Streams of lower gradient and/or more open valleys with a wide/broad floodplain support southwestern willow flycatcher breeding habitat in Southern Nevada. Nesting habitat is largely associated with perennial stream flow that supports thickets of trees and shrubs ranging in height from two to thirty meters. Southwestern willow flycatcher food availability may be largely influenced by the presence of moist soils, which attracts the insects that southwestern willow flycatchers are known to consume (USFWS 2005:60908-60912). Some of the habitat for southwestern willow flycatcher along the Lower Virgin River is associated with agricultural return flows (SWCA 2007:62-63). Approximately 474 acres of southwestern willow flycatcher habitat has been identified along the Virgin River, occurring around Littlefield, Arizona, Mesquite, Nevada, and Mormon Mesa (SWCA 2007:20-26).

Yuma clapper rail was listed as federally endangered in 1967. It is a marsh obligate species that is found in freshwater habitats along the Colorado River and its associated drainages, including the Lower Virgin River. Preferred Yuma clapper rail habitat consists of mature cattail-bulrush stands in shallow water near high ground. Stands of cattails (*Typha spp.*) and bulrush (*Scirpus spp.*) dissected by narrow channels of flowing water have been observed to support the densest populations of birds (USFWS, 1983:7). The marsh habitat found along the Lower Virgin River that supports Yuma clapper rail is typically dominated by cattail and bulrush (Braden 2006:1). It is estimated that about 412 acres of marsh habitat occur along the Lower Virgin River (USBR 2004b:3.4-17)

In contrast to the Upper Virgin River, the Lower Virgin River is largely unaltered by dams or reservoirs. Some portions of the Lower Virgin River have been known to go dry during the summer months due to upstream water uses combined with the effects of drought and the complex geology and braiding of the channel resulting in underflow. However, the river is susceptible to a natural flood cycle that is unimpeded by dams and reservoirs in the Lower Virgin River. These natural floods may temporarily impact the habitat of southwestern willow flycatcher and Yuma clapper rail (SWCA 2007:21, Braden 2006:2). As mentioned above, a natural flood event in January 2005 did impact habitat along the Lower Virgin River. However, recent surveys have shown that the vegetation is returning and this natural cycle of the Virgin River is not anticipated to have long-term impacts on bird species (SWCA 2007:21).

Based on historical surveys and recent surveys by SWCA Environmental Consultants and the San Bernardino County Museum, the Yuma clapper rail occurs within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18). The southwestern willow flycatcher has been observed along the Virgin River at Littlefield, Mesquite, and Mormon Mesa (SWCA 2007:20-27).

Brown pelican (*Pelecanus occidentalis*) and the recently delisted bald eagle (*Haliaeetus leucocephalus*) have not been observed on the Virgin and Muddy Rivers. Surveys conducted by San Bernardino County Museum on both rivers from 1999 to 2005 have not detected the species (Braden 2005: 3.24-3.28; Braden 2006: 21-28). In addition, brown pelicans are known to feed by visual detection and plunge diving (Ashmole 1971). Turbid waters, such as the Virgin and Muddy Rivers, are typically avoided by brown pelicans (Ainley 1975; Murphy 1936).

Lower Virgin River Candidate Bird Species. One candidate bird species is known to occur within the Lower Virgin River. The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) was designated as a candidate species for listing under the Endangered Species Act in 2001 (USFWS 2001:38611). The species is found in stream-side willow habitats along the Lower Virgin River consisting of willow, tamarisk, Fremont cottonwood (*Populus fremontii*), and honey mesquite (Braden 2006:1). Based on historical surveys and recent surveys by the San Bernardino County Museum, western yellow-billed cuckoos occur within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18).

Lower Virgin River Fish Species. Based on data collected after 1984 and more recent sampling conducted by Bio-West Inc. it appears that the dominant fish populations are non-native species (USFWS 1995: 11-12; Bio-West, Inc. 2007: 16, 19, 22, 24). Non-native fish that occur within the Lower Virgin River include black bullhead (*Ameiurus melas*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Miceropterus salmoides*), western mosquitofish (*Gambusia affinis*), red shiner (*Cyprinella lutrensis*), and blue tilapia (*Oreochromis aureus*) (Bio-West, Inc. 2007:16).

One fish species protected by a conservation agreement is known to occur within the Lower Virgin River. Virgin spinedace (*Lepidomeda mollispinis mollispinis*) was protected by the multi-agency Virgin Spinedace Conservation Agreement and Strategy finalized in 1996. The goal of the agreement is to reestablish and maintain water flows, enhance and maintain spinedace habitats, maintain genetic viability, and monitor populations. The Virgin spinedace is a small silvery minnow no more than two to four inches in length. The species tends to frequent pools with instream vegetation or boulders (Utah Division of Wildlife Resources 2002:4-5). The Virgin spinedace is extremely rare in the Lower Virgin River but one was observed in 2005 (Bio-West Inc. 2007:14).

Lower Virgin River Endangered Fish Species. Two federally endangered fish species are known to occur within the Lower Virgin River: woundfin (*Plagopterus argentissimus*) and Virgin River Chub (*Gila seminuda*). Woundfin was listed as endangered in 1970. The species is a streamlined, silvery minnow that is found within runs and quiet waters adjacent to riffles (USFWS 1995:v). Virgin River chub was listed as endangered in 1989. The species is a silvery, medium-sized minnow that averages 8 inches in total length but can grow as much as 18 inches. Virgin River chubs are most often associated with deep runs or pool habitats of slow to moderate velocities with large boulders or instream cover (USFWS 1995:v).

Bio-West Inc. has observed limited numbers of native fish species. In Fall 2005, 49 flannelmouth suckers (*Catostomus latipinnis*), 46 desert suckers (*Catostomus clarki*), 321 speckled dace (*Rhinichthys osculus*), four woundfin, 57 Virgin River Chub, and one Virgin spinedace were documented (Bio-West Inc. 2007:14, 18, 20, 23). Competition and predation from non-native fish species, drought, increased water temperature, and increased water clarity, are all identified as impacts to native fish species within the Virgin River (Bio-West, Inc. 2007:1). Although non-native fish species are found throughout the Lower Virgin River, they tend to be more prevalent below the Bunkerville Diversion (Bio-West, Inc. 2007: 16, 19, 22, 24). The Bunkerville Diversion is considered to be acting as a partial fish barrier for non-native species moving upstream from Lake Mead.

Muddy River Bird Species. The various riparian habitats along the floodplain of the Muddy River within the proposed action area support a variety of wildlife species. Overall, the same bird species found on the Virgin River are also found on the Muddy River. The riparian habitats are important sources of water, cover and foraging for many species. Probably the most diverse wildlife to use the habitat is bird species. Bird species that occur are both year-round residents and migratory.

Muddy River Candidate Bird Species. The candidate bird species, western yellow-billed cuckoo, is also known to occur on the Muddy River. The species is found in stream-side willow habitats along the Muddy River consisting of willow, tamarisk, Fremont cottonwood (*Populus fremontii*), and honey mesquite (Braden 2006:1). Western yellow-billed cuckoos have been observed in the Muddy River area on Warm Springs Ranch near the headwaters of the river and at Honeybee Pond within the Overton Wildlife Management Area (Braden 2006:17-18).

Muddy River Endangered Bird Species. The Muddy River provides habitat for the same endangered bird species that occur on the Lower Virgin River. Much of the habitat requirements are also the same. However, on the Muddy River, southwestern willow flycatcher habitat is not associated with agricultural return flows.

Based on historical surveys and recent surveys by the San Bernardino Museum, Yuma clapper rails have been observed in the Muddy River area at Honeybee Pond within the Overton Wildlife Management Area and within Maverick ditch behind the Maverick gas station on South Moapa Valley Boulevard just north of Lewis Avenue. Southwestern willow flycatchers have been observed within Overton Wildlife Management Area (SWCA 2007:27). It is estimated about 390 acres of riparian habitat that may support southwestern willow flycatcher is located within the Overton Wildlife Management Area (USFWS 2005: 60922).

Muddy River Fish Species. Based on historical data and more recent sampling conducted by Bio-West Inc., it appears that the dominant fish populations are non-native species (Bio-West Inc. 2005:9). Fish that occur within the Muddy River include black bullhead, channel catfish, common carp, green sunfish, largemouth bass, western mosquitofish, red shiner, and blue tilapia (Bio-West Inc. 2005:7).

Virgin River chub is also found on the Muddy River, however, when the Virgin River chub was listed in 1989, the Muddy River population was excluded from the listing. Therefore, the Virgin River chub found within the Muddy River is not currently protected under the Endangered Species Act (USFWS 1995:v).

Bio-West Inc. collected six Virgin River Chub just below the Wells-siding Diversion in May 2004, four at Cooper Road and one at Lewis Avenue. In addition one speckled dace was collected at the Wells-siding Diversion and one at Gubler Road (Bio-West Inc. 2005:9).

Muddy River Endangered Fish Species. The only endangered fish species in the Muddy River is the Moapa dace (Moapa coricea). Moapa dace was listed as endangered in 1967. It occupies approximately 6 miles of stream habitat in the thermal headwaters of the Muddy River, known as Warm Springs. The species can only successfully reproduce in the thermal spring outflows of the Muddy River headwaters which range from 85- 90 ºF in temperature (USFWS 1996:ii). In February 2007, 1,172 Moapa dace were counted within the upper Muddy River (S. Goodchild, personal communication February 22, 2007).

B.3.5.2 Critical Habitat

Lower Virgin River Endangered Fish Species. On January 26, 2000, the U.S. Fish and Wildlife Service (USFWS) listed critical habitat for woundfin and Virgin River chub within the Virgin River flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada (USFWS 2000:4141). Figure 3 shows the critical habitat designated within the action area. Competition and predation from non-native fish species, drought, increased water temperature, and increased water clarity, are all identified as impacts to native fish species within the Virgin River (Bio-West, Inc. 2007:1).

Muddy River Endangered Fish Species. No critical habitat has been designated for Moapa dace.

Lower Virgin River and Muddy River Endangered Bird Species. On October 19, 2005, the USFWS designated 73.8 miles of the Virgin River as critical habitat for the southwestern willow flycatcher (USFWS 2005:60922). Critical habitat on the river is contiguous from the Washington Field diversion impoundment in Washington County, Utah, downstream through the town of Littlefield, Arizona, and ends at the upstream boundary of the Overton State Wildlife Area in Clark County, Nevada. Figure 3 shows the critical habitat designated within the action area.

No critical habitat has been designated for the Yuma Clapper Rail.

B.4 Species Accounts for Potentially Affected Federally Listed and Candidate Species

This section describes further detail on those plant and animal species that are listed by the USFWS as threatened, endangered or candidate that may occur in the project area.

B.4.1 Virgin River Chub (*Gila seminuda*)

Federal Status: *Endangered* (Virgin River Population)

The Virgin River population of the Virgin River chub has been classified as endangered by the USFWS. Recent genetic studies of the Virgin River Chub on the Muddy River have concluded it is genetically identical to the Virgin River Chub on the Virgin River. The USFWS is currently undergoing status review of the Muddy River Population of the Virgin River Chub to determine whether that population is proposed for listing. This section describes both populations.

Table 4
Summary of Federally Listed and Candidate Species That May Occur in the Project Area

Species	Status	Range and Habitat of Species	Occurrence in Action Area
Fish			
Virgin River Chub (Virgin River Population) (Gila seminude)	E CH	Occurs within the virgin River in deep runs or pools of slow to moderate velocities with large boulders and in stream cover.	The Virgin River Chub is currently distributed within the Virgin River from La Verkin Springs, Utah to the diversion at Mesquite, Nevada USFWS 1970). The species has occurred in Halfway Wash but not downstream to Lake Mead. Critical habitat is from Utah to Halfway Wash.
Virgin River Chub (Muddy River Population) (Gila seminude)	E	Occurs within the Muddy River in deep runs or pools of slow to moderate velocities with sand, large rocks, and cover in the form of overhanging banks and tree roots.	This species has occurred historically from Warm Springs to Logandale. Based on recent surveys this species has been collected just below the Wells-siding diversion to several miles downstream.
Moapa Dace (Moapa coriacea)	E	Occur in spring pools, tributaries and the main portion of the Muddy River, but only reproduces in tributary thermal spring outflows.	This species is restricted to the upper Muddy River because of its affinity for warmer water. It is not expected to occur below the Wells-siding Diversion.
Woundfin (Plagopterus argentissimus)	E CH	Occurs in the Virgin River in run and quiet water regimes adjacent to riffles with sand substrate.	Occurs within the Virgin River from La Verkin Springs to just below Halfway Wash in Nevada. Critical habitat is from La Verkin to Halfway Wash.
Birds			
Western Yellow-billed Cuckoo (Coccyzus americanus occidentalis)	C	Occurs in mature cottonwood willow habitat in the southwestern United States	The western yellow-billed cuckoo occurs along the Muddy River and Virgin River within the project area.
Southwestern Willow Flycatcher (Empidonax traillii extimus)	E	Occurs in many locations in southwestern United States. Preferred habitat within NV is desert riparian habitats along rivers, and streams supporting willows, mulefat, or other riparian vegetation.	The southwestern willow flycatcher occurs within the project area along the Virgin River and Muddy Rivers.
Yuma Clapper Rail (Rallus longirostris yumanensis)	E	Occurs in freshwater marshes and requires regenerating marsh for foraging ad mature stands of cattail and bulrush for nesting.	The Yuma clapper rail occurs within the project area along the Virgin and Muddy Rivers.

E – Federally endangered   T – Federally threatened   C – Federal candidate for listing   CH – Critical Habitat has been designated for species within action area

Species Biology. The Virgin River chub is in the minnow family. Although the typical individual is approximately 8 inches in length, the species can reach up to 18 inches in length (USFWS 2006d). Adults and juveniles inhabit deep runs or pools with slow to moderate velocities (up to 2.5 ft/s) over sand and having instream cover such as boulders. It is not present in water above 30°C (90°F) (USFWS 2006d). The Virgin River chub is omnivorous, eating algae, terrestrial and aquatic insects, organic detritus, and crustaceans; young fish feed primarily on invertebrates while adults eat algae and debris (USFWS 2006d). The species has a high tolerance for turbidity and salinity. Factors that currently limit the Virgin River chub include habitat loss and modification, and non-native fish (USFWS 2006d).Periods of spawning have not been well documented, but appear to coincide with the spawning periods for the woundfin.

Species Habitat and Range. Its distribution was thought to be restricted to the Virgin River, but more recent work has found that the roundtail chub found in the Muddy River is also the Virgin River chub. The current distribution of the Virgin River chub in the Virgin River is from Pah Tempe Springs in Utah to at least the Mesquite diversion near the Arizona-Nevada border (USFWS 2000). It historically was collected in the Virgin River from La Verkin Springs, Utah to the confluence of the Virgin River into the Colorado River. It also was collected in the Muddy River in Nevada. The fish is most often associated with deep runs or pools within the river.

Current Conditions Range Wide. The Virgin River chub is currently restricted to the Virgin and Muddy Rivers. It seems stable in those habitats; although the species is vulnerable to impact due to its limited distribution, increase of non-native species, water diversions and other disturbances.

Occurrence in Project Area. The Virgin River Chub is currently distributed within the Virgin River from La Verkin Springs, Utah to the diversion at Mesquite, Nevada (USFWS 1995). The Virgin River has been sampled most recently by Bio-West Inc. and by the Virgin River Fishes Recovery Team (VRFRT).

Distinct sample sites have been located at Halfway Wash, the Overton Wildlife Management Area (OWMA), and Virgin River Bowl and just above Lake Mead. Data collected from 2001 to 2004 indicates that the Virgin River Chub may no longer be present below Halfway Wash. The reason for the possible loss of this species is the long-term drought conditions and the dominance of non-native fish species. Recent data collected indicates that non-native species of fish are dominant in the lower portion of the river below Halfway Wash (Bio-West, Inc. 2007).

The Muddy River Population of the Virgin River chub was isolated from the Virgin River population by the construction of Hoover Dam and the filling of Lake Mead (USFWS 1996). The Virgin River chub Muddy River population has historically occurred in most abundance between the Warm Springs area and Logandale. The chub was rarely found below the I-15 Freeway and not below the Wells-siding diversion dam (USFWS 1996). Field studies by Bio-West, Inc. (2005) in 2004 found 31 Virgin River chub in there May survey. Surveys were conducted from the Wells-siding Diversion downstream to Lake Mead. Sample sites included

Wells-siding diversion, above Route 169, Route 169, below Route 169, Gubler Road, Yamashita road, Cottonwood road, Cooper road, Lewis Road, OWMA Diversion Dam, and the end of the river channel. With the exception of a year old fish, all were young of the year. Most of the fish caught were immediately below the Wells-siding Diversion, but 4 were found at Cooper Road and another at Lewis Road. In September 2005 Golden and Holden collected twelve adult and one young of the year immediately below the Wells Siding Diversion.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the Virgin River Habitat Conservation and Recovery Program (VRHCRP) as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address Virgin River chub on the Virgin River.

Currently, Coyote Springs Investment (CSI), the Moapa Band of Paiutes, the Moapa Valley Water District, USFWS and SNWA are developing the Muddy River Recovery Implementation Program (MRRIP) to provide coverage for future groundwater development in Coyote Spring Valley. The MRRIP proposes to address the Muddy River population of the Virgin River chub.

Designated Critical Habitat. Approximately 140.1 km (87.5 mi) of the Virgin River within the 100-year flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada has been designated as Critical Habitat for the Virgin River population of this species (65 FR 4140-4156). This area is the last remaining occupied habitat for this species.

B.4.2 Moapa Dace (*Moapa coriacea*)

Federal Status: *Endangered*

Species Biology. The Moapa dace is federally-listed as endangered (USFWS 2006e). Moapa dace can grow to 4.7 inches. Adults prefer the main stem of the river as well as tributaries while juveniles prefer tributaries and areas with increasing velocity as they grow. Reproduction occurs all year but peaks in the spring. Threats to the species include non-native fish species and fish parasites brought in with the non-native fish. Moapa dace spawn year round with peak spawning activity in spring and a smaller peak in fall. Sexual maturity occurs in approximately one year. Moapa dace have only been found to successfully breed in warm water ranging between 86 and 89.6 degrees F (USFWS 1996). The dace is omnivorous eating a wide variety of aquatic insects and plants.

Species Habitat and Range. Moapa dace are endemic to the upper Muddy River and tributary thermal spring systems within the Warm Springs Area. Historically, the fish may have occupied as many as 25 springs and 10 miles of river habitat. Cooler water in the middle and lower Muddy River were likely a natural barrier to downstream movement of Moapa dace (USFWS 1996). The species currently occupies approximately 5.9 miles of stream habitat with five springs. This habitat ranges downstream to near the Warm Springs Road Bridge.

Cady Lamb, Baldwin, Muddy, Apcar, and Pederson Springs provide the warm water flows to this habitat.

Current Conditions Range Wide. The species appears relatively stable in its present distribution.

Occurrence in Project Area. The species is restricted to the upper Muddy River due to its affinity for warmer water, which is produced by the stream complex feeding the Muddy River. Therefore, it would not occur at or below the Wells Crossing Diversion Structure. Fish surveys did not find the species below the Warm Springs Road bridge (Bio-West, Inc. 2005).

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, Coyote Springs Investment (CSI), the Moapa Band of Paiutes, the Moapa Valley Water District, USFWS and SNWA are developing the MRRIP to provide coverage for future groundwater development in Coyote Spring Valley. The MRRIP proposes to address Moapa dace.

Designated Critical Habitat. No critical habitat has been designated for this species.

B.4.3 Woundfin (*Plagopterus argentissimus*)

Federal Status: *Endangered*

Species Biology. The woundfin is a small (less than 3.5 inches) fish in the minnow family with a life span of up to 4 years (NatureServe 2006). Adults are generally found in water less than 1.4 feet deep with velocities between 0.8 and 1.6 ft/s while juveniles occur in slower and deeper waters (USFWS 2000). Both use runs and quiet waters over sand or gravel adjacent to riffles. Larvae are found along the stream margin and in backwaters, often being associated with filamentous algae. Spawning occurs from April to July when water flows are declining (USFWS 2006c) over cobbles to gravel (NatureServe 2006). Woundfin are omnivorous, feeding on filamentous algae, detritus, tamarisk seeds, and insects (USFWS 2006c). Current threats to the species include habitat loss and degradation, competition from non-native fish, and predation. Spawning occurs in the spring months when the water levels are high and water temperatures rather low. Species survival tends to be dependent upon flow conditions and water temperature.

Species Habitat and Range. The woundfin historically ranged within the Colorado River from Yuma to the Virgin River in Nevada, Utah and Arizona. It also extended from the confluence of the Salt and Verde Rivers to the mouth of the Gila River near Yuma. A single individual was collected in the Muddy (Moapa) River (formerly a tributary of the Virgin River but now flows into the Overton Arm of Lake Mead) in the late 1960s, but it has not been found there since then (USFWS 2000). The woundfin has been extirpated from almost all of its historic range except for the Virgin River. Woundfin presently range from Pah Tempe (La Verkin) Springs, Utah on the main stem of the Virgin River and the lower portion of La Verkin Creek, Utah downstream to Lake Mead, Nevada (USFWS 1995).

Woundfin adults and juveniles are normally collected from runs and quiet waters adjacent to riffles. Juveniles generally use areas that are slower and deeper than those areas used by adults. Adults prefer water temperatures near 64 degrees F (USFWS 1995).

Current Conditions Range Wide. As described above, the woundfin is now restricted to the Virgin River.

Occurrence in Project Area. The Virgin River has been sampled most recently by Bio-West Inc. and by the VRFRT. Distinct sample sites have been located at Halfway Wash, OWMA, Virgin River Bowl and just above Lake Mead. They have both found that the woundfin is distributed as far downstream as Halfway Wash. The woundfin has been collected historically, but sporadically at Halfway Wash. The last known record of this species at Halfway Wash or downstream from there is in 1999 when two woundfins were collected by the VRFRT at Halfway Wash (Bio-West, Inc. 2005). No other woundfin have been collected at Halfway Wash or downstream with the most recent sampling event conducted by Bio-West in 2004.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address woundfin.

Designated Critical Habitat. Approximately 140.1 km (87.5 mi) of the Virgin River within the 100-year flood plain from the confluence of Ash and La Verkin creeks, Utah to Halfway Wash, Nevada has been designated as Critical Habitat for the species (65 FR 4140-4156). This area is the last remaining occupied habitat for this species.

B.4.4 Western Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*)

Federal Status: Candidate

Species Biology. The western yellow-billed cuckoo breeding season occurs in late May through early August. Nests are constructed of a variety of plant material and are concealed in a bush or tree at 2 to 20 feet from the ground. A clutch is generally 3 to 4 eggs and is incubated by the female for 9 to 11 days, with occasional help from the male. Nestlings are tended to by both parents and can fly about 21 days after hatching.

Species Habitat and Range. Western yellow-billed cuckoo is generally found in streamside cottonwood/willow and alder groves, open woodlands, parkland, gardens and orchards. Within the United States their breeding range includes areas of Idaho, Utah, California, Arizona and southern Nevada, and throughout most of the continent east of the Rocky Mountains to the Atlantic Coast. In Nevada, the western yellow-billed cuckoo is considered a rare and transient resident.

Current Conditions Range Wide. More information is needed on population size and occurrences of this species. The species is being reduced because of the loss of suitable habitat.

Occurrence in Project Area. Western yellow-billed cuckoo is currently known to occupy areas along the Muddy and Virgin Rivers in Southern Nevada with suitable habitat occupied intermittently among the years.

Surveys for western yellow-billed cuckoo have been conducted on the Muddy and Virgin rivers by the San Bernardino County Museum (Braden 2006). Eleven study sites were surveyed on the Virgin River and 5 sites were surveyed on the Muddy River. Survey sites on the Virgin River included three sites at Littlefield, Arizona, three sites near Mesquite, Nevada, three sites below Mormon Mesa and a site at Fisherman's Cove and at the Virgin River Landing (Braden 2006). Based on historical surveys and recent surveys by the San Bernardino County Museum, western yellow-billed cuckoos occur within the Virgin River and have been observed at Littlefield, Mesquite, Mormon Mesa, and the Virgin River Landing (Braden 2006:17-18).

The five sites surveyed on the Muddy River included Warm Springs Ranch near Glendale, Nevada, three sites near Overton, Nevada, and one site at Logandale, Nevada.

Western yellow-billed cuckoos have been observed in the Muddy River area on Warm Springs Ranch near the headwaters of the river and at Honeybee Pond within the Overton Wildlife Management Area (Braden 2006:17-18).

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address western yellow-billed cuckoo.

Designated Critical Habitat. No critical habitat for the western yellow-billed cuckoo has been identified.

B.4.5 Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

Federal Status: *Endangered*

Species Biology. The southwestern willow flycatcher is a small bird with an almost exclusive diet of insects. It usually nests in close proximity to water or very saturated soils. Often the habitat will dry up during the nesting season, but there still must be enough water to support riparian vegetation.

The species migrates into the area and normally nests in dense willow and salt cedar. After nesting is completed and young have fledged, individuals may disperse into other riparian areas.

Species Habitat and Range. The southwestern willow flycatcher is a small passerine bird that occupies riparian areas in southern California, New Mexico, southern Nevada, south central Colorado, Utah, west Texas and Arizona. The subspecies species usually nests in riparian habitat along rivers, streams, open water, cienegas, marshy seeps and or saturated soil where sense growth of riparian habitat occurs. The areas are typically dense growth of willows, baccharis, arrow weed, and salt cedar sometimes with an overstory of cottonwood. (Sogge, et al. 1997). The species typically nests in dense riparian areas with canopies 13-23 feet tall. Historically, the species nested primarily in dense willow habitat, but is now found in mixed habitats containing salt cedar.

Current Conditions Range Wide. The willow flycatcher is a riparian obligate species. Riparian habitat within its range has declined for a number of reasons including large-scale loss of wetlands, and degradation of riparian habitat through invasion of introduced plant species such as salt cedar. Brood parasitism by brown-headed cowbirds is also a major threat to nesting success.

Occurrence in Project Area. The southwestern willow flycatcher nests in a number of locations on the Lower Virgin River. Surveys are conducted on a yearly basis by SWCA, Inc. for the U.S. Department of Interior, Bureau of Reclamation (BOR) (SWCA 2007).

The following sites were surveyed along the Virgin River:

1) **Littlefield, Arizona.** The Littlefield site consist of two study areas, Littlefield North and South near the confluence of the Virgin River with Beaver Dam Wash. These sites include a stand of cottonwood with an understory of willow, salt cedar and Russian olive. No willow flycatchers were detected at either location in 2006.

2) **Mesquite, Nevada.** The Mesquite site consists of two study areas, Mesquite West and East. The Mesquite sites consisted of a mosaic of bulrush and cattail marshes separated by strips of willow and salt cedar. This vegetation is supported by runoff from two golf courses immediately adjacent to the site. Twenty-four resident breeding flycatchers were located at Mesquite West in 2006. One pair was detected at Mesquite East in 2006.

3) **Mormon Mesa North, Nevada.** This site is the farthest north of 6 sites located in the 15 km segment upstream from Lake Mead. This area is in a wide (1km) floodplain of the Virgin River. The area consists of a mosaic of habitat including salt cedar and willow forest, cattail forest and mixed native and exotic forests. No flycatchers were detected at Mormon Mesa North in 2006.

4) **Mormon Mesa South, Nevada.** Vegetation in this area consists of salt cedar with patches of willow and cattail. One willow flycatcher was detected at this location in 2006.

5) **Virgin River #1, Nevada.** This site consisted of areas of dense salt cedar with other areas containing a mixture of willows and salt cedar. One pair and two unpaired males were detected at this site in 2006.

6) **Virgin River #2, Nevada.** This site is a monotypic stand of dense salt cedar. In 2006, 11 resident breeding willow flycatchers, seven unpaired males were detected at this site.

One study site has been maintained on the lower Muddy River on the OWMA. The site consisted primarily of salt cedar with some willow. Ten resident breeding willow flycatchers and one unpaired male were detected in 2006.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address southwestern willow flycatcher.

Designated Critical Habitat. On October 19, 2005 the USFWS designated 73.8 miles of the Virgin River as critical habitat for the southwestern willow flycatcher (FR70 60886 – 61009). Critical habitat on the river is contiguous from the Washington Field diversion impoundment in Washington County, Utah, downstream through the town of Littlefield, Arizona, and ends at the upstream boundary of the Overton State Wildlife Area in Clark County, Nevada. The Critical habitat within the project area is within the Virgin Management Unit – Virgin River, NV/AZ/UT that is within the Lower Colorado Recovery Unit – Nevada, California/Arizona Border, Arizona, and Utah

The OWMA while having features essential to the southwestern willow flycatcher is being excluded from the critical habitat designation. The reason for the exclusion is the area is already being managed by the state of Nevada for wildlife and riparian habitat for the flycatcher.

B.4.6 Yuma clapper rail (*Rallus longirostris yumanensis*)

Federal Status: *Endangered*

Species Biology. The breeding season for the Yuma Clapper Rail occurs in March through August. Nests are built with plant stems and grasses within the marsh on elevated ground. Live vegetation is often pulled over the nest to form a canopy and conceal the nest. A clutch is generally made up of 8 to 11 eggs. Males and females incubate the eggs for 20 to 24 days. Nestlings are independent of the parents in 35 to 42 days and able to fly 63 to 70 days after hatching.

Species Habitat and Range. The Yuma Clapper Rail is a marsh obligate species found in freshwater habitats along the Colorado, Muddy, and Virgin Rivers as well as isolated portions of the Salton Sea, California (Braden 2006).

Current Conditions Range Wide. More information is needed on population size and occurrences of this species. The species is being reduced because of the loss of suitable habitat.

Occurrence in Project Area. Yuma Clapper Rail is currently known to occupy areas along the Muddy and Virgin Rivers in Southern Nevada with suitable habitat occupied intermittently among the years.

Surveys for Yuma clapper rail have been conducted on the Muddy and Virgin Rivers by the San Bernardino County Museum (Braden 2006). Eleven study sites were surveyed on the Virgin River and 5 sites were surveyed on the Muddy River. Survey sites on the Virgin River included three sites at Littlefield, Arizona, three sites near Mesquite, Nevada, 3 sites below Mormon Mesa and a site at Fisherman's Cove and at the Virgin River Landing (Braden 2006). The five sites surveyed on the Muddy River included Warm Springs Ranch near Glendale, Nevada, three sites near Overton, Nevada, and one site at Logandale, Nevada. The following is brief description of the current survey sites within the project area.

- Virgin River:
  - Mormon Mesa (Big Marsh, East Marsh and Long Marsh)
    1) Big Marsh is located along the northwestern bank of the Virgin River near Mormon Mesa. The marsh is fed by a springs and inflow from the river. Habitat in the marsh consists of dense stands of cattail with limited amounts of water.
    2) East Marsh is a small area east of the Virgin River and northeast of long marsh. East Marsh inflows are from spring runoff from the river.
    3) Long Marsh is a linear marsh habitat that parallels the river channel and is on the west side of the river. The habitat consists of cattail, tamarisk, and various willows.
  - Virgin Delta (Virgin River Landing and Fisherman's Cove)
    1) Virgin River Landing and Fisherman's Cove prior to 2003 were inundated by Lake Mead. In 2004 the sites supported dense stands of cattail with black willow and some tamarisk.
- Muddy River
  - Logandale (Bowman Canal, and Grant Bowler Park)
    1) Bowman Canal an overflow and runoff catchment for Bowman reservoir. The canal supports patches of cattails.
    2) Grant Bowler Park is located in Grant Bowler Park in downtown Logandale. The survey area is a stretch of the Muddy River that is adjacent to the park. The area consists of cattails with patches of tamarisk and willow.

3) Overton (Maverick Ditch)

4) The Maverick Ditch is located in the ton of Overton near the intersection of Cooper and Jones Streets. The site is dominated by cattail, bulrush, tamarisk, and yerba mansa.

5) OWMA (Honeybee Pond)

6) Honeybee Pond is located on the OWMA. The habitat is composed of cattail, and reeds surrounded by water impoundments.

Yuma clapper rail have been recorded sporadically over the last five years along the Virgin River within the Littlefield, Mesquite, Mormon Mesa and Virgin River Delta (Braden 2006). They have never occurred in large numbers and in many instances occur infrequently. Floods in January of 2005 have altered the habitat for these species, especially in the Mesquite area. In 2004 one rail was detected at Big Marsh and 2 rails were detected at the Virgin River Landing. This is the first year individuals were observed since the site emerged in 2002 (Braden 2006).

Yuma clapper rail have been recorded sporadically over the last five years at Honeybee Pond and Maverick Ditch in the Overton area of the Muddy River (Braden 2006). The Muddy River also experienced flooding during January of 2005, altering habitat for the Yuma clapper rail.

Other Actions by Federal, State or Local Agencies Affecting the Species in the Project Area. Currently, the City of Mesquite is developing the VRHCRP as a requirement to the Mesquite Lands Act. The VRHCRP is intended to provide coverage for impacts associated with the development of the Mesquite area and proposes to address Yuma clapper rail.

Designated Critical Habitat. No critical habitat for the Yuma clapper rail has been identified.

B.5 Effects Analysis

B.5.1 Effects to Lower Virgin River Hydrology

Tributary conservation ICS flows of 10,000 afy of water on the Virgin River, if averaged monthly, would equate to approximately 830 acre-feet per month and 30 acre-feet per day. These numbers represent averages and may not correspond to actual diversion schedules for the irrigation company water rights being used for tributary conservation since irrigation company schedules do not allow water users to take a constant stream of water and the schedules change throughout the season and from year to year. This makes it difficult to estimate a precise schedule for delivery of tributary conservation flows. However, assuming water is delivered at least weekly, the average weekly water contribution from tributary conservation would be approximately 210 acre-feet per week. If a gage were installed directly below the lowest return point of the retired water it would probably not reflect an increase of the entire 210 acre-feet per week due to complex geology and underflow that occurs in the floodplains and along the entire Virgin River. Additionally, the gage would have a margin of error of at least 10% and the 10,000 afy of tributary conservation represents less than 7% of the historic annual flow in the Virgin River at Halfway Wash. Therefore, any change measured by the gage would be within the gage's margin of error, so the accuracy of any gage measurement of tributary conservation flows would be questionable. Finally, surface water rights in Nevada are not subject to forfeiture (NRS 533.060(2)), so purchasers of water rights are not required to divert and use this water to guard against forfeiture. Therefore, the water rights that SNWA purchased may have already been regularly fallowed or out of production at the time they were acquired by SNWA. This means that water SNWA would be accounting for as tributary conservation may already be flowing in the river, so a response in a streamflow gage from tributary conservation flows may not be detected. Due to all of the factors mentioned above, 10,000 afy of tributary conservation is not likely to result in a noticeable change to flows on the Virgin River from the current conditions listed in Table 2.

B.5.2 Effects to Muddy River Hydrology

Tributary conservation flows of 20,000 afy of water on the Muddy River, if averaged monthly, would equate to approximately 1,700 acre-feet per month and 55 acre-feet per day. These numbers represent averages and may not correspond to actual diversion schedules for the irrigation company water rights being used for tributary conservation since irrigation company schedules do not allow water users to take a constant stream of water and the schedules change throughout the season and from year to year. This makes it difficult to estimate a schedule for delivery of tributary conservation flows. However, assuming water is delivered at least monthly, the average monthly water contribution from tributary conservation would be approximately 1,700 acre-feet. The Overton gage probably would not reflect an increase of the entire 1,700 acre-feet per month due to complex geology and underflow that occurs before the Overton gage on the Muddy River. Additionally, surface water rights in Nevada are not subject to forfeiture (NRS 533.060(2)), so purchasers of water rights are not required to divert and use this water to guard against forfeiture. Therefore, the water rights that SNWA purchased may have already been regularly fallowed or out of production at the time they were acquired by SNWA. This means that water SNWA would be accounting for as tributary conservation may already be flowing in the river, so a response in the streamflow gage from tributary conservation flows may not be detected.

Upper Muddy River surface water flow is measured at the Moapa and Glendale gages, which average approximately 30,000 afy. The current leased SNWA water rights in the Upper Muddy River (1,000 afy) represent approximately 3% of the gages' flow, well within a typical gage margin of error of 10% and virtually undetectable.

In the Lower Muddy River, the surface flows are measured at the Overton Gage which averages approximately 9,000 afy. The Overton Gage is very near the top of full pool elevation in Lake Mead (1,229 ft-AMSL). Therefore, this gage is believed to reflect surface water flows reaching Lake Mead. While there have been no studies confirming irrigation system losses to the alluvium, it is believed that there is water bypassing the Overton gage as underflow. Because of irrigation system losses and substantial underflow bypassing the gage, simply subtracting the Moapa-Glendale gage readings from the Overton gage readings will not provide an accurate accounting of the volume of tributary conservation flow reaching Lake Mead. Like the Virgin River and Upper Muddy River, the complex geology, gaging accuracies, and historic use of this water will make it difficult to see a marked increase in the Overton Gage from tributary conservation flows. In addition, the limited period of record for the Overton Gage when compared with the Glendale Gage, and uses between the two gages suggests large volumes of water bypass the gage as underflow. Due to all the factors mentioned above, 20,000 afy of tributary conservation is not likely to result in a noticeable change to flows on the Muddy River from the current conditions listed in Table 3.

B.5.3 Effects to Species

As discussed above, flooding has the potential to periodically impact riparian habitat, resulting in naturally occurring impacts to bird species (SWCA, 2007:21). However, the tributary conservation water associated with the proposed action (approximately 1,700 acre-feet per month on the Muddy River and 830 acre-feet per month on the Virgin River) should not cause flood flows or exacerbate natural flood events because the capacity of the two river systems has been determined to be more than adequate to accommodate the proposed tributary conservation flows. Given that the mean monthly gage flow for the Virgin River at Littlefield Arizona ranges from 6,641 acre-feet to 26,380 acre-feet, an additional 830 acre-feet per month is minimal compared to the overall flows in the river. Similarly, on the Muddy River the mean monthly gage flow at the Overton gage ranges from 483 acre-feet to 1,113 acre-feet, and the 1,700 acre-feet per month of tributary conservation water is not anticipated to exacerbate flood flows because of the complex underflow system on the Muddy River. In general, tributary conservation flows are expected to have a beneficial, albeit minor, effect on any marsh or riparian habitat associated with the southwestern willow flycatcher, Yuma clapper rail, or yellow-billed cuckoo located along the Muddy River or within the Mormon Mesa area on the Virgin River. No effect is anticipated for southwestern willow flycatcher, Yuma clapper rail, or yellow-billed cuckoo on the Virgin River above the Bunkerville Irrigation Company service area, as tributary conservation will take place below this area.

Drought has been identified as one type of event that could create conditions that can impact sensitive fish species on the Lower Virgin River and the Muddy River. The assured flows in the Virgin and Muddy Rivers proposed by the SNWA tributary conservation program are expected to have a minor beneficial effect on the endangered and candidate fish and bird species because they may help lessen the effects of drought (Bio-West Inc. 2007:1). While drought tends to decrease river flows, the tributary conservation flows are expected to act as an assured baseflow for sensitive fish and bird species on the Muddy River and below the Bunkerville Irrigation Company service area on the Virgin River. There is a concern that additional flows on the Virgin River may connect the Virgin River to Lake Mead for more days during the year, possibly allowing more non-native species to move up the Virgin River from Lake Mead. However, the small amount of additional flow possible (830 acre-feet per month in tributary conservation versus 6,641 acre-feet to 26,380 acre-feet per month average river flow), coupled with the complex geology of the Virgin River and braiding of the river in that location suggests that a more permanent connection will not be made between the Virgin River and Lake Mead because much of the minor additional flow will reach Lake Mead as underflow. Therefore, this project may affect, but is not likely to adversely affect the endangered and candidate bird and fish species in the Lower Virgin and Muddy Rivers because the potential positive effects are expected to be difficult to meaningfully measure or detect and are therefore insignificant (See hydrology discussion in Sections 5.1 and 5.2) .

B.5.3.1 Southwestern Willow Flycatcher

Riparian habitat that may support southwestern willow flycatcher tends to form at the agricultural returns along the banks of the Lower Virgin River (SWCA 2007:62-63). Potential effects to southwestern willow flycatcher may occur on the Lower Virgin River if the water conserved through tributary conservation is no longer routed through the Bunkerville Irrigation Company ditch systems because this change in operations would result in a loss of agricultural returns that may support the habitat in some areas. However, Bunkerville Irrigation Company will need the tributary conservation water to remain in the ditch systems, even if it is not used for agricultural purposes, because the water is needed to maintain head within the ditch systems so water can be withdrawn for irrigation. If the tributary conservation water is not retained in the ditch systems, Bunkerville Irrigation Company would need to upgrade the ditches to accommodate less flow. On July 21, 2005, the SNWA Board of Directors agreed to keep SNWA water rights used for tributary conservation in the ditches to avoid impacts to southwestern willow flycatcher habitat and to Bunkerville Irrigation Company operations. Therefore, the project will have no effect on the southwestern willow flycatcher within the ditch system of the Bunkerville Irrigation Company because there will be no change in ditch flows from this project.

Flows that were historically consumptively used off channel by agriculture will be used for the creation of tributary conservation. Though this may result in a small positive effect on river flows and underflow along the Muddy and Virgin River, which could benefit the riparian habitats of the southwestern willow flycatcher, these flow effects will be difficult to meaningfully measure or detect as indicated in Sections 5.1 and 5.2. This project is not expected to result in take of southwestern willow flycatcher. Therefore, this project may affect, but is not likely to adversely affect the southwestern willow flycatcher because the effects are expected to be insignificant downstream of the agricultural returns from the Bunkerville Irrigation Company service area in Mormon Mesa and along the Muddy River to Lake Mead.

Southwestern Willow Flycatcher Critical Habitat. As mentioned previously, riparian habitat that may support southwestern willow flycatcher tends to form at the agricultural returns along the banks of the Lower Virgin River (SWCA 2007:62-63). Some of these riparian habitat areas may occur within critical habitat for the southwestern willow flycatcher. There is potential to affect critical habitat for the species if the water conserved through tributary conservation is no longer routed through the Bunkerville Irrigation Company ditch systems because the agricultural returns that support the habitat will cease. However, as noted above, effects to southwestern willow flycatcher critical habitat will be by retaining the tributary conservation water within the ditch systems of the irrigation company. Based on this, it is anticipated that there will be no destruction or adverse modification to southwestern willow flycatcher critical habitat on the Lower Virgin River, and thus no impact to recovery opportunities.

There is no critical habitat for the southwestern willow flycatcher designated on the Muddy River. However, there is Southwestern willow flycatcher habitat on the Muddy River within the Overton Wildlife Management Area (OWMA) that was excluded from the designation of critical habitat since this area is already being managed for wildlife and riparian habitat by the State of Nevada. Assured flows associated with tributary conservation are likely to have a minor beneficial effect on the development and maintenance of southwestern willow flycatcher habitat in the OWMA. For the reasons indicated in Section 5.3.1, this project may affect, but is not likely to adversely affect the southwestern willow flycatcher.

Southwestern Willow Flycatcher Recovery Plan. The Southwestern Willow Flycatcher Recovery Plan has an overall recovery objective to attain a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations (USFWS 2002a: 77). The recovery plan states that there are currently an estimated 40 known territories within the Virgin River. In order to downlist the species from endangered to threatened, a minimum of 100 known territories needs to be present on the Virgin River (USFWS 2002a: 87). No such recovery goal exists for the Muddy River.

Tributary conservation flows in both the Virgin and Muddy Rivers will help maintain and/or develop southwestern willow flycatcher habitat and will assist with meeting the recovery goals for the species. As described above, the assured flows from tributary conservation in the Muddy River and in the Virgin River below the Bunkerville Irrigation Company service area may help support existing southwestern willow flycatcher habitat or develop new habitat because flows that were historically consumptively used by agriculture will be used for tributary conservation. It is anticipated that there will be no destruction or adverse modification to southwestern willow flycatcher habitat on the Lower Virgin River or Muddy River, and thus no adverse impact to recovery opportunities. Because tributary conservation will help to maintain or create additional habitat, it is consistent with the recovery plan goals.

B.5.3.2 Yuma Clapper Rail

Yuma clapper rail occupies marsh habitat along the Virgin and Muddy Rivers which is maintained by river flow and not agricultural returns. Since tributary conservation water will be a part of the river flows that support the habitat, no adverse effects to Yuma clapper rail have been identified on either river for the proposed action. Consequently, the project is not expected to result in take of Yuma clapper rail. Tributary conservation may benefit the Yuma clapper rail by assuring flows, thereby maintaining existing habitat and potentially developing new habitat areas in the Muddy River and in the Virgin River below the Bunkerville Irrigation Company service area. However, the potential changes in flows in the Muddy and Virgin Rivers will be difficult to measure or detect (Sections 5.1 and 5.2). Therefore, this project may affect, but is not likely to adversely affect the Yuma clapper rail because the effects are expected to be insignificant.

No critical habitat has been designated for the Yuma Clapper Rail.

Yuma Clapper Rail Recovery Plan. The primary objective of the Yuma Clapper Rail Recovery Plan is to assure the continued survival of a total breeding population of 700-1,000 Yuma clapper rails in the United States. Consideration for delisting the Yuma clapper rail will be based on an assessment of the population in both the United States and Mexico (USFWS 1983: 12). A five-year status review of the species was conducted in 2006. In that review the USFWS was unable to determine if the primary objective of the recovery plan had been met due to population fluctuations associated with changes in survey effort, survey protocol, observer experience, and habitat changes (USFWS 2006a: 6). However, tributary conservation on the Virgin and Muddy Rivers will assure flows and thereby help maintain existing habitat and potentially develop new habitat areas for the Yuma Clapper Rail in the Muddy River and the Virgin River below the Bunkerville Irrigation Company service area, which is consistent with recovery plan goals.

B.5.3.3 Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo habitat along the Virgin and Muddy Rivers is maintained by river flow and not agricultural returns. As described above, the assured flows from tributary conservation in the Muddy River and the Virgin River below the Bunkerville Irrigation Company service area may help support existing western yellow-billed cuckoo habitat. Consequently, the project is not expected to result in take of yellow-billed cuckoo. However, the potential changes in flows in the Muddy and Virgin Rivers will be difficult to measure or detect (Sections 5.1 and 5.2). Therefore, this project may affect, but is not likely to adversely affect the western yellow-billed cuckoo because the effects are expected to be insignificant.

There is no designated critical habitat for the western yellow-billed cuckoo.

B.5.3.4 Woundfin and Virgin River Chub

In the Virgin River non-native fish species are more prevalent downstream from the Bunkerville Diversion, although they do occur throughout the Lower Virgin River (Bio-West Inc. 2007:16, 19, 22, 24). There is a concern that the higher flows coupled with a possible change in maintenance or operation of the Bunkerville Division will allow additional non-native species to move upstream, which may impact the woundfin and Virgin River chub in the Virgin River. However, SNWA has agreed that its water will continue to be diverted and flow through the ditch systems of the irrigation company, so no change in the operation or maintenance of the Bunkerville Diversion is anticipated as part of the tributary conservation project. It is anticipated that the Bunkerville Diversion will continue to function as a partial barrier to upstream movement of non-native fish during low flows. Although the Bunkerville Diversion is a less effective fish barrier during high flows, the movement of non-native fishes past the Bunkerville Diversion is not expected to increase from current conditions because the possible additional flows are minor and may be manifested as underflow (See Sections 5.1 and 5.2). The small amount of additional flow (830 acre-feet per month in tributary conservation versus 6,641 acre-feet to 26,380 acre-feet per month average river flow), coupled with the complex geology of the Virgin River and braiding of the river at that location suggests that a more permanent connection will not be made between the Virgin River and Lake Mead because much of the minor additional flow will reach Lake Mead as underflow. Consequently, this project is not expected to adversely affect woundfin and Virgin River Chub in the Virgin River by increased opportunity for non-native fish movement upstream of the Bunkerville Diversion. In addition, the Virgin River Fishes Recovery Team and the Lower Virgin River Recovery Implementation Team are developing plans for a fish barrier at Halfway Wash. If installed, the fish barrier will effectively stop most, if not all, upstream movement of non-native fishes from Lake Mead.

Before 2007, woundfin had not been observed below the Bunkerville Irrigation Company service area along the Virgin River since 2001 (Bio-West, Inc. 2007: 23). However, in 2007, Bio-West, Inc. did document one woundfin within the Riverside reach below the Bunkerville Irrigation Company service area (B. Albrecht, personal communication July 12, 2007). It is anticipated that the tributary conservation water in the system may have a minor beneficial effect on the woundfin by providing assured flows below the Bunkerville Irrigation Company service area. However, as indicated in Sections 5.1 and 5.2, these additional flows will be difficult to meaningfully measure or detect. No additional predation by non-native fish species is anticipated because the minor additional flows will not provide enough water to result in a more permanent connection between the Virgin River and Lake Mead. Given the complex geology of the Virgin River at Lake Mead and the fact that the river channel is braided in that area, it is likely that the minor flows associated with tributary conservation will be manifested as underflow where the Virgin River meets Lake Mead. Therefore, this project may affect, but is not likely to adversely affect the woundfin because the potential effects are expected to be insignificant.

In the Virgin River, no effect to the Virgin River chub is anticipated because the tributary conservation flows will only be below the Mesquite and Bunkerville Irrigation Company service areas and Virgin River chub have not been collected below the Mesquite Diversion since the late 1970's (USFWS 1995: 9). As indicated in Section 5.2, flows from SNWA leased water in the Upper Muddy River will be virtually undetectable and therefore are not likely to adversely affect Virgin River Chub here because the flow effects are insignificant.

Woundfin and Virgin River Chub Critical Habitat. The critical habitat for the woundfin and Virgin River chub has historically been impacted by low flows on the Virgin River (USFWS 2000:4142). tributary conservation on the Virgin River is anticipated to have a beneficial, though minor, effect on critical habitat for the woundfin and Virgin River chub. To the extent that tributary conservation flows are not manifested as underflow below the Bunkerville Irrigation Company service area, tributary conservation may provide assured flows that can create additional species habitat and help lessen the effects of drought. Even if no beneficial effect on critical habitat is created from tributary conservation, degradation of critical habitat is not expected. No destruction or adverse modification to designated woundfin or Virgin River chub critical habitat is anticipated and, thus there will be no impact to recovery opportunities.

Virgin River Fishes Recovery Plan. The Virgin River Fishes Recovery Plan contains recovery goals for both the Virgin River chub and woundfin. The objective of the plan is to downlist both of the species from endangered to threatened. In order to meet the requirements for downlisting the following criteria must be met: (1) Virgin River flows essential to survival of all life stages are protected; (2) degraded Virgin River from Pah Tempe Springs to Lake Mead is upgraded and maintained to allow continued existence of all life stages at viable population levels; and (3) barriers to upstream migration of introduced fishes are established, red shiner is eliminated, and other nonnative species which present a major threat to the continued existence of the fish community are reduced (USFWS 1995:v). No additional predation by non-native fish species is anticipated to result from tributary conservation because the minor additional flows will not provide enough water to result in a more permanent connection to Lake Mead. Given the complex geology of the Virgin River at Lake Mead and the fact that the river channel is braided in that area, it is likely that the minor flows associated with tributary conservation will be manifested as underflow where the Virgin River meets Lake Mead. Tributary conservation may help meet the first criteria for downlisting by providing a minor amount of assured flows for woundfin, which have been recently found below the Bunkerville Irrigation Company service area, therefore the project is consistent with recovery plan goals.

B.5.3.5 Moapa Dace

Moapa dace is limited to the Warm Springs area along the Muddy River because of the temperature requirements of the species. The species has only been found within the first 6 miles of the river system (USFWS 1996:4). Assured water flows in that area via tributary conservation will consist of water from the water rights lease between SNWA and the LDS Church and possible purchases from other users. Part of the 1,000 afy of tributary conservation obtained through a lease in the upper portion of the Muddy River is already flowing unused in the Muddy River system. No additional changes are proposed as part of the tributary conservation project in the upper Muddy River and, therefore, no effect on the Moapa dace is anticipated as part of this project.

There is no critical habitat designated for the Moapa dace.

Recovery Plan for Rare Aquatic Species of Muddy River Ecosystem. The Recovery Plan for Rare Aquatic Species of the Muddy River Ecosystem contains recovery goals for the Moapa dace. The objective of the plan is to downlist the Moapa dace from endangered to threatened. In order to meet the requirements for downlisting, the following criteria must be met: (1) existing instream slows and historical habitat in three of the five spring systems in the upper Muddy River have to be protected through conservation agreements, easements, or fee title acquisitions; (2) 4,500 adult Moapa dace must be present among the five spring systems in the upper Muddy River; and (3) the Moapa dace population must be comprised of three or more age-classes, and reproduction and recruitment is documented from three spring systems (USFWS 1996: 33-34). Tributary conservation may help meet the second and third criteria for downlisting by counteracting the effects of low flows on the species. Therefore, this project is consistent with the recovery plan goals.

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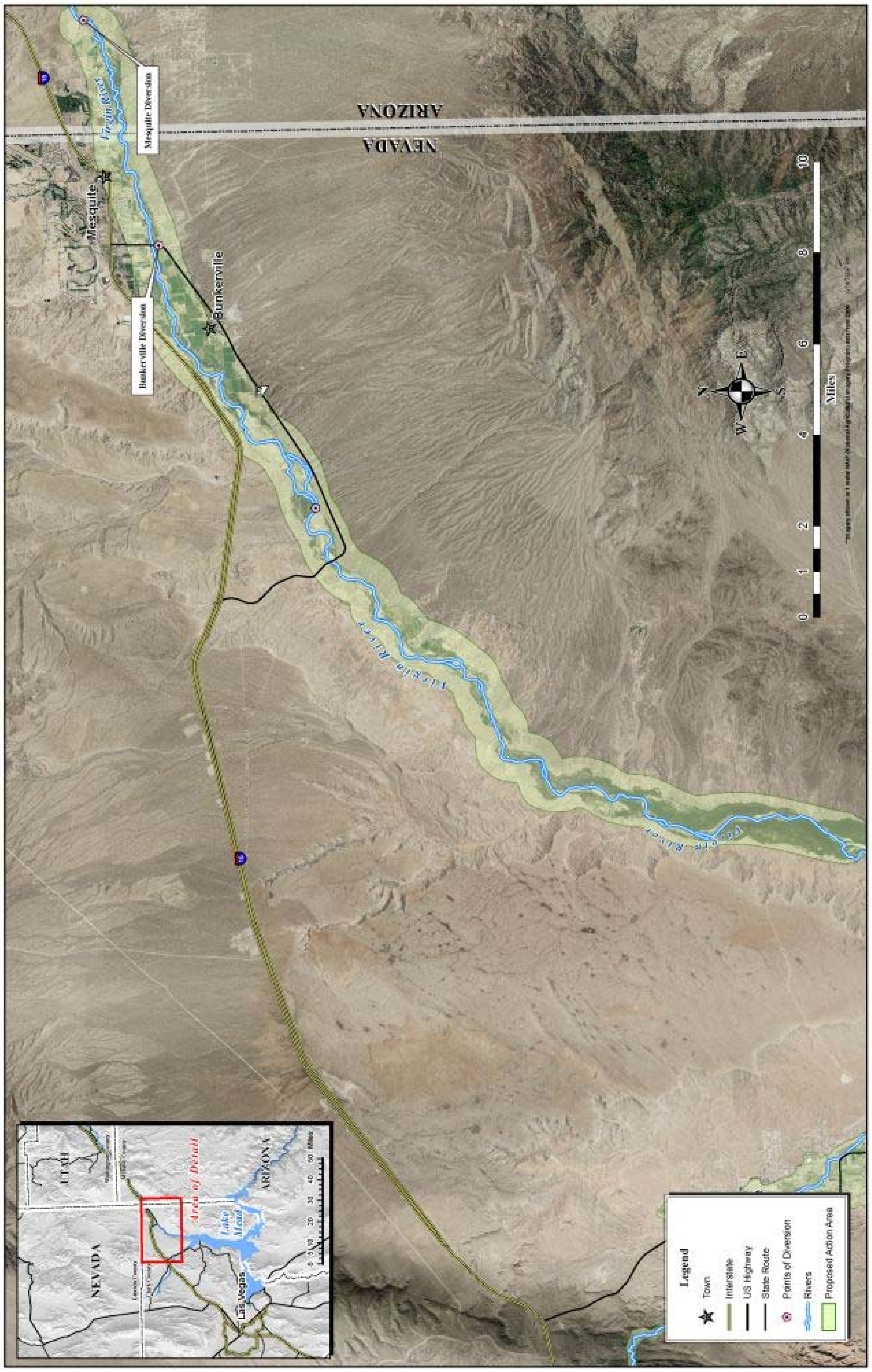


Figure 1
Action Area in the Lower Virgin River

Figure 2
Action Area in the Muddy River

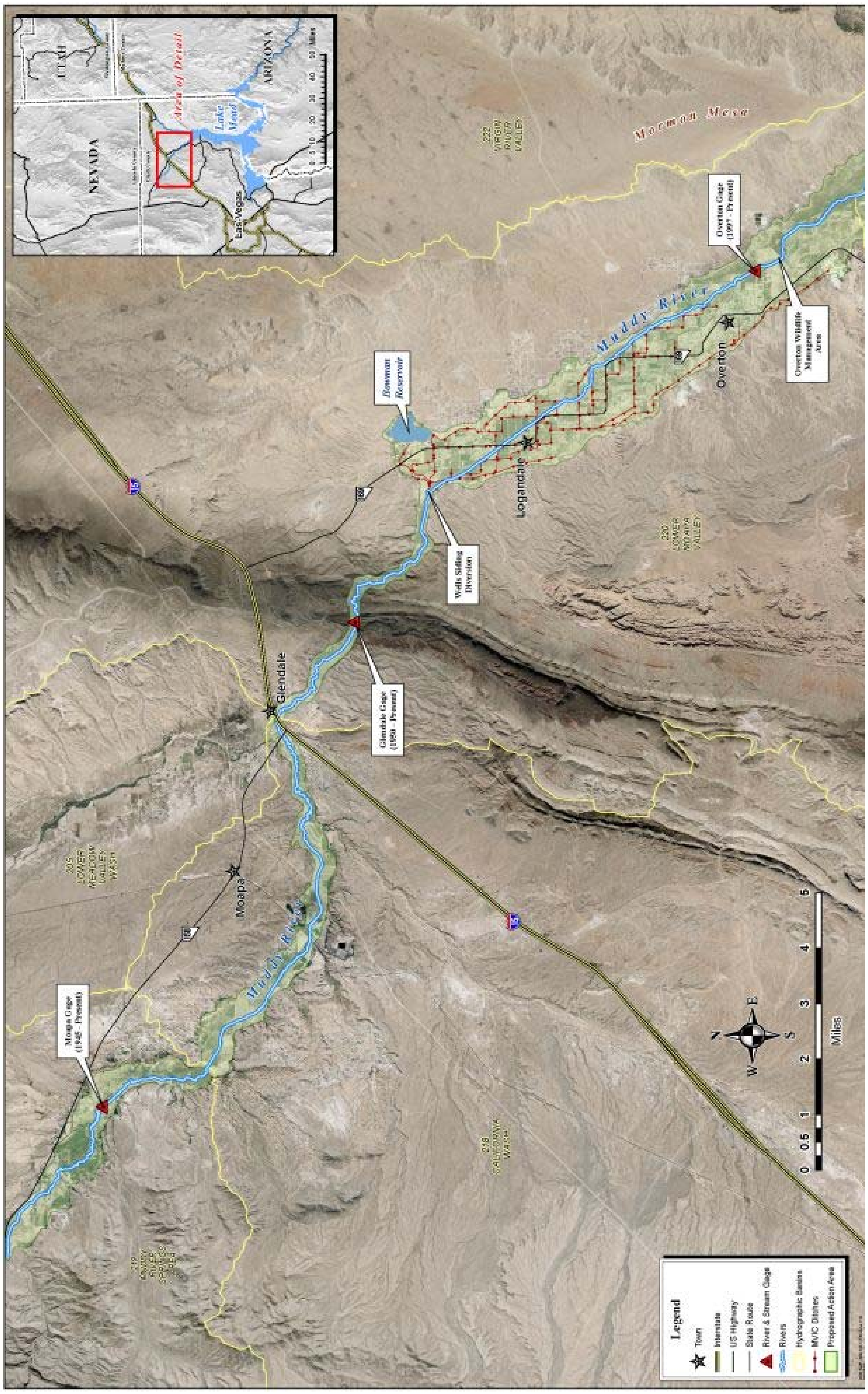
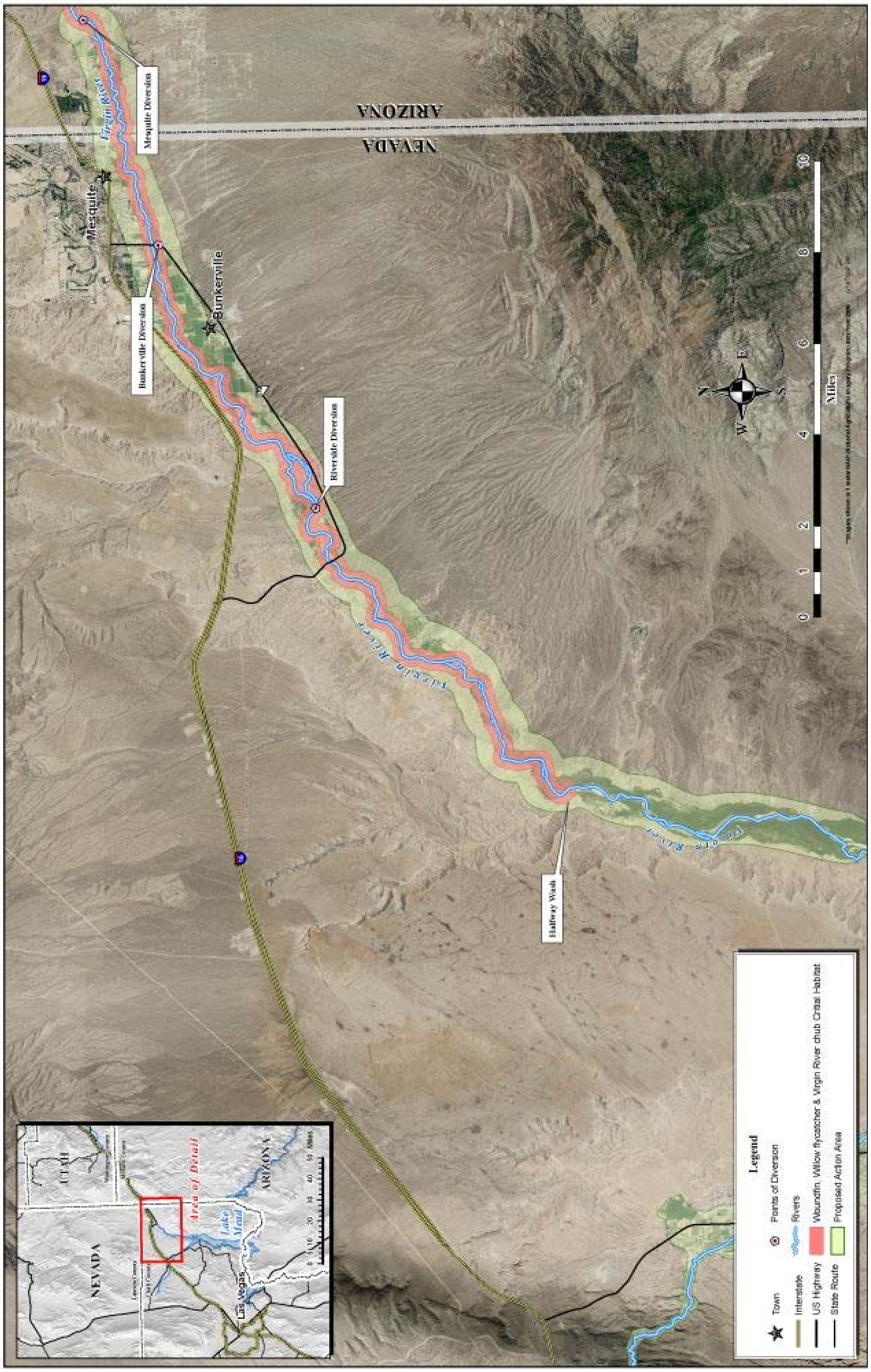


Figure 3
Critical habitat designated for woundfin and Virgin River chub within the Virgin River



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Attachment C

CRSS Model Outputs

This attachment to Appendix R describes the reservoir and river flow modeling outputs used in this biological assessment from Reclamation's Colorado River Simulation System (CRSS), as implemented in the RiverWare™ modeling system.

Figure BA-1
Lake Powell End-of-July Water Elevations
Comparison of Preferred Alternative to No Action Alternative
Percent of Values Greater than or Equal to Elevation 3,660 feet msl

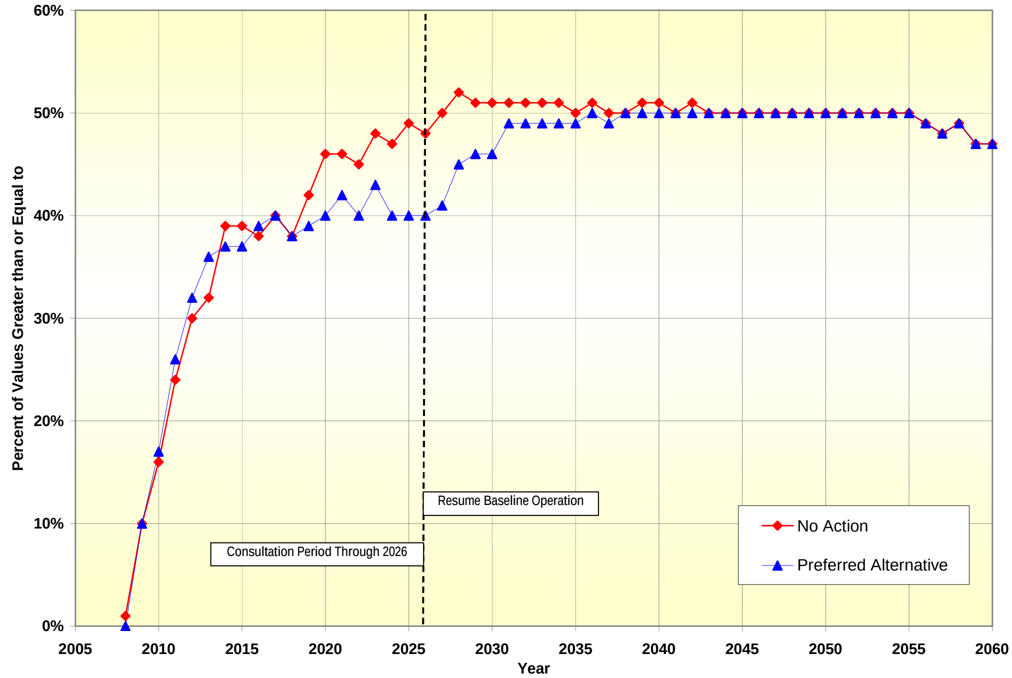

Figure BA-2
Lake Powell End-of-March Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

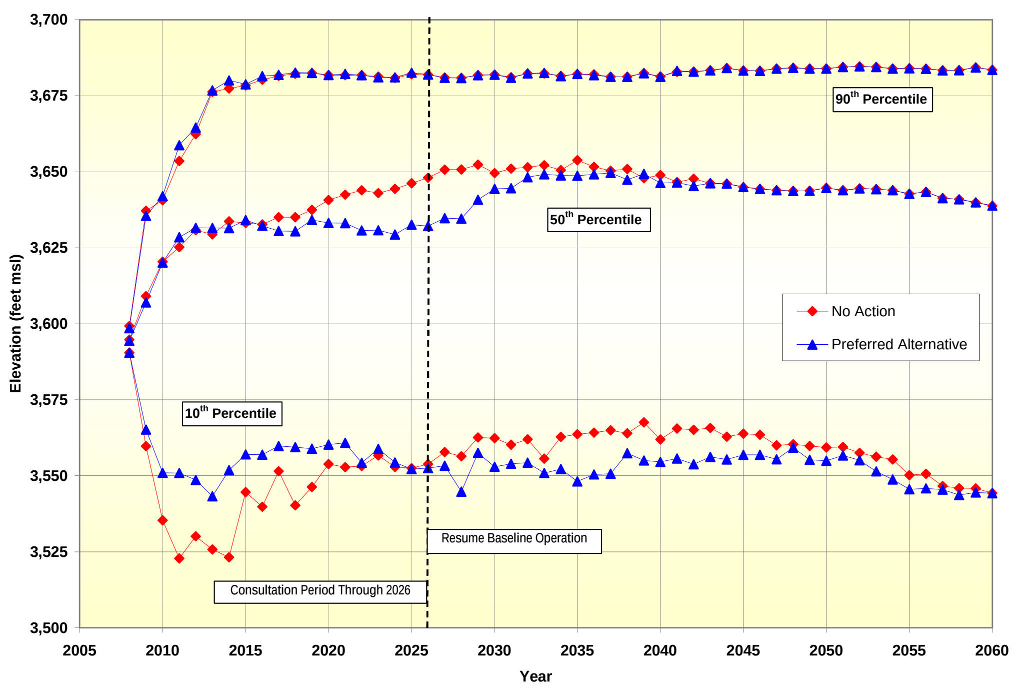

Figure BA-3
Lake Powell End-of-December Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

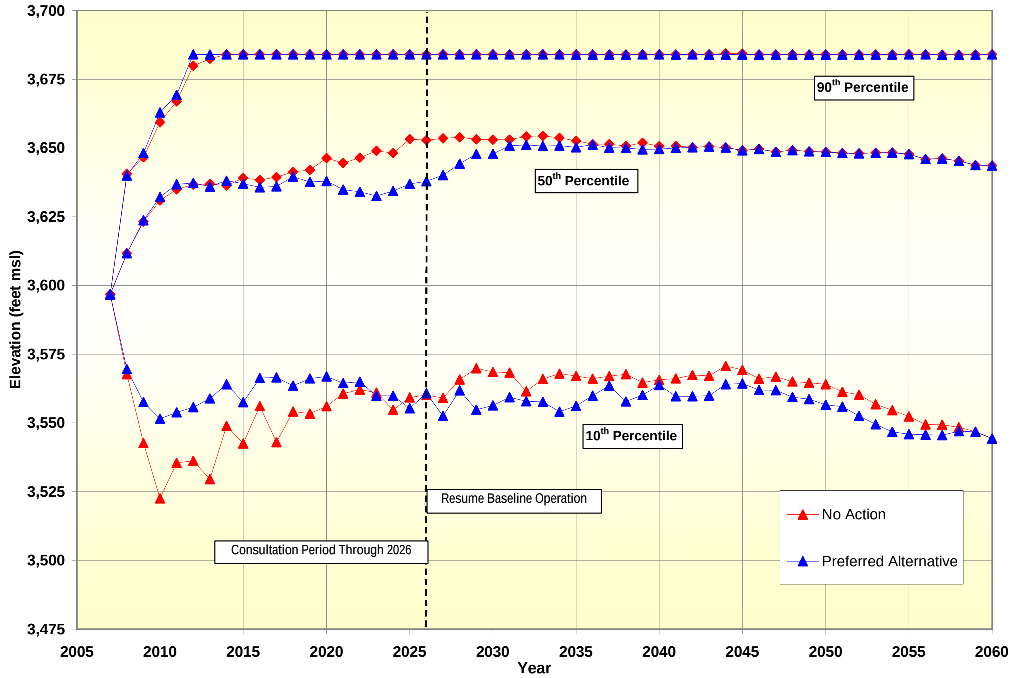

Figure BA-4
Lake Powell End-of-July Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

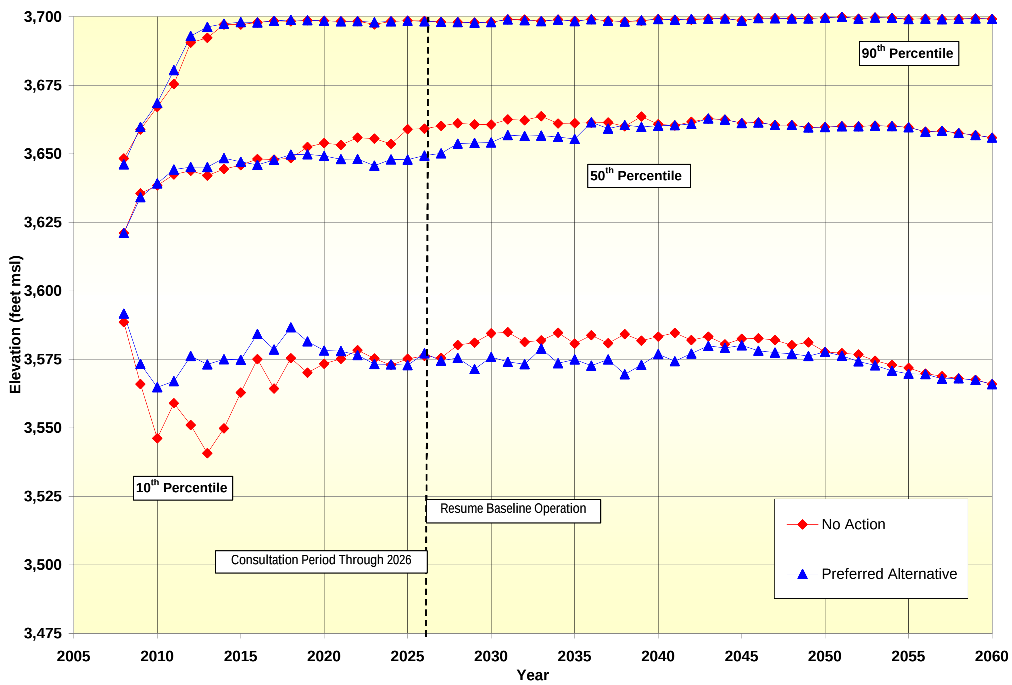

Figure BA-5
Lake Powell End-of-September Water Elevations
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

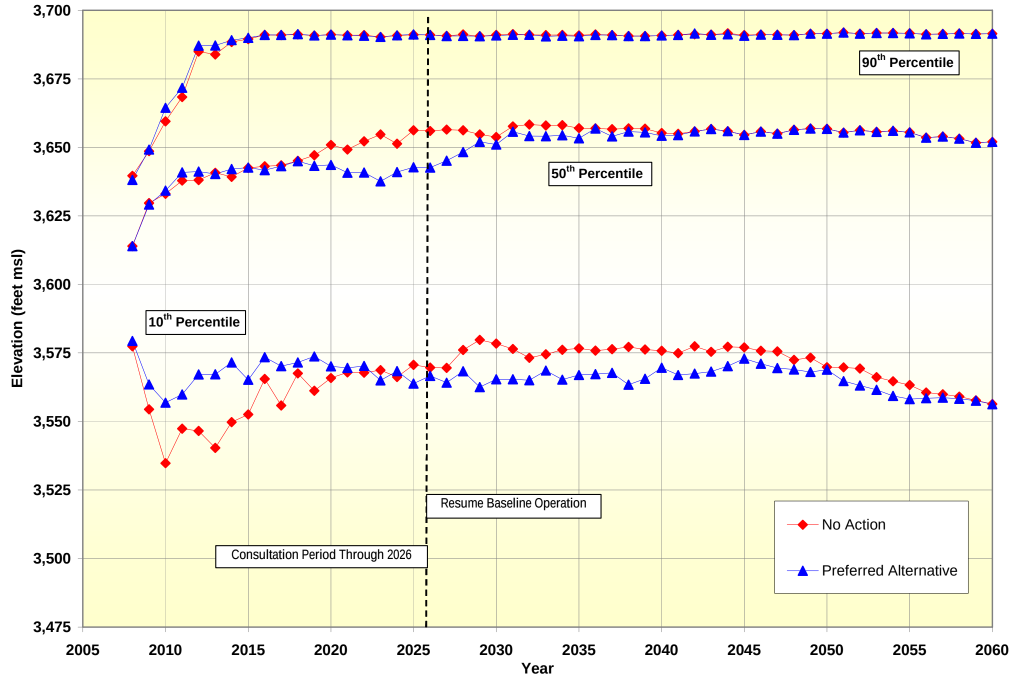

Figure BA-6
Glen Canyon Dam January Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

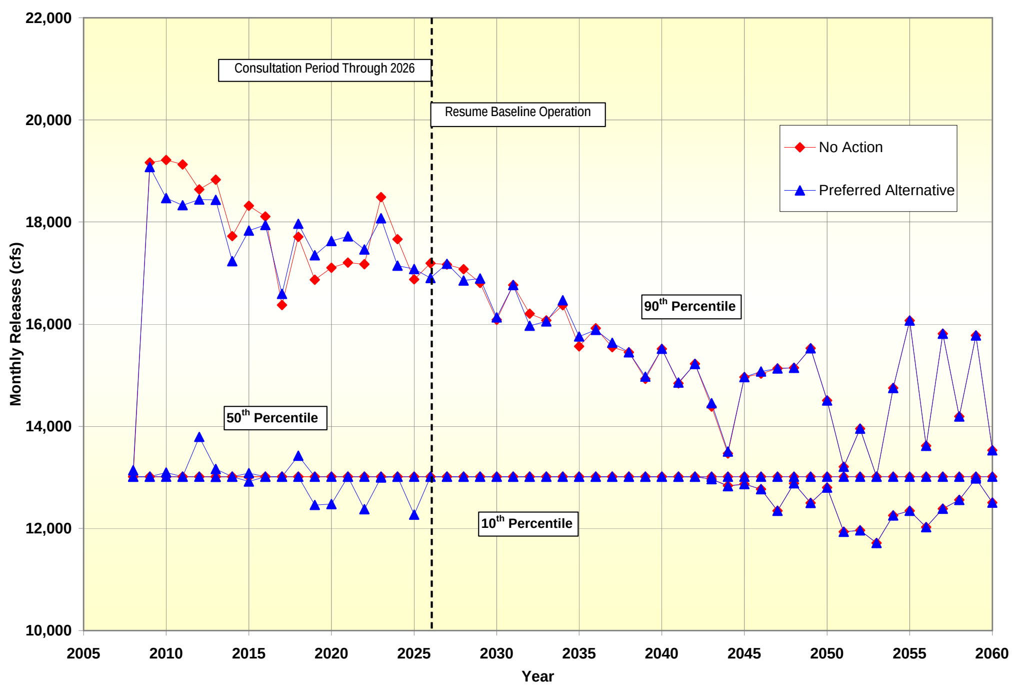

Figure BA-7
Glen Canyon Dam February Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

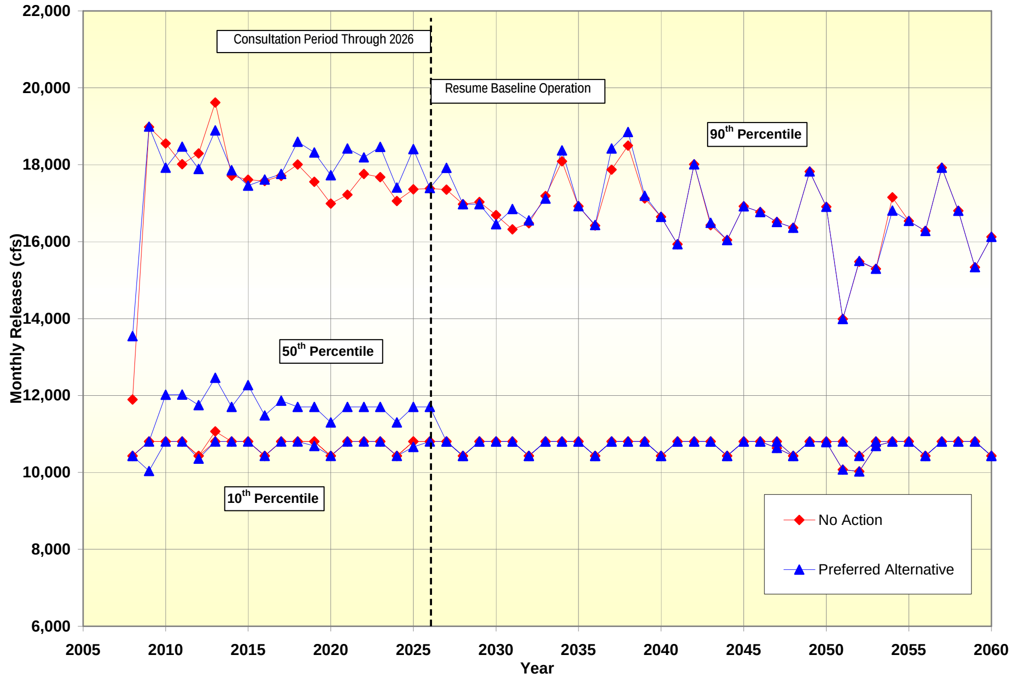

Figure BA-8
Glen Canyon Dam March Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

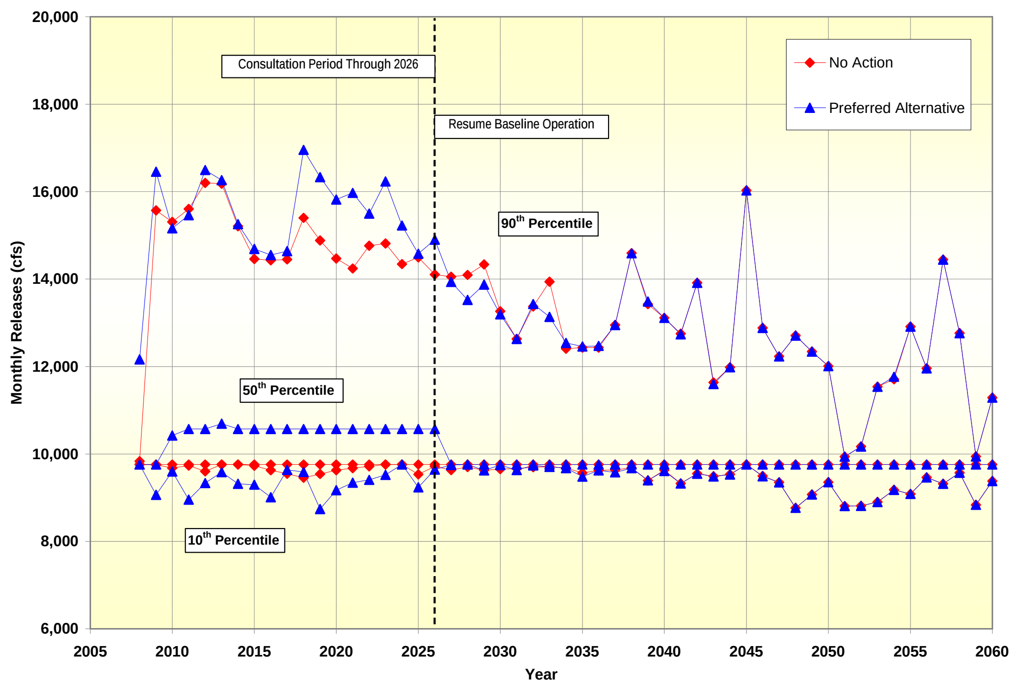

Figure BA-9
Glen Canyon Dam April Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

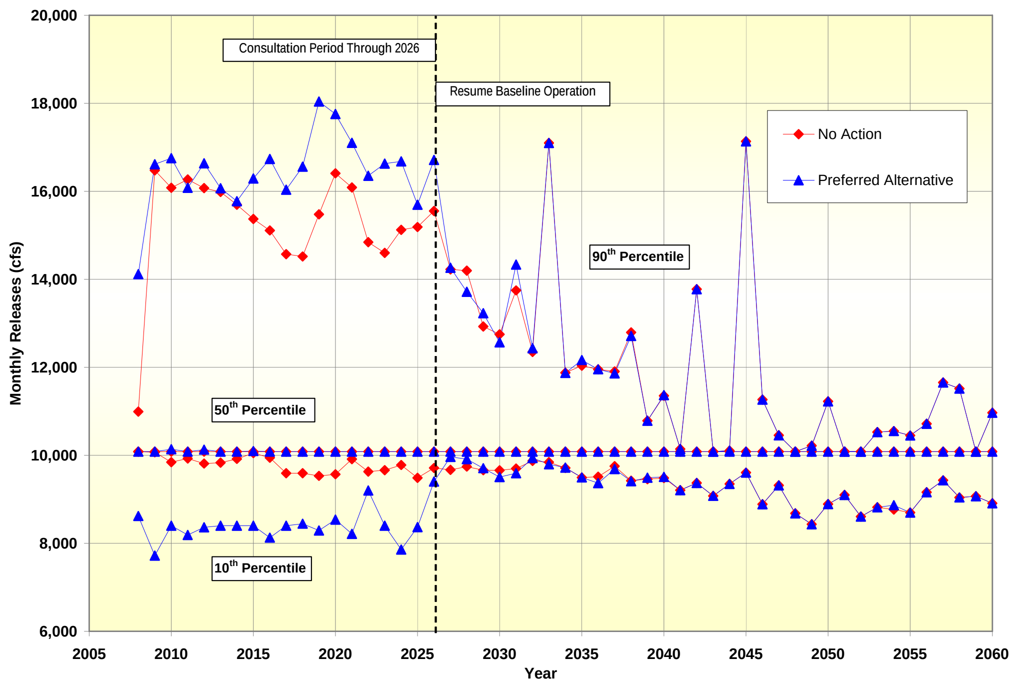

Figure BA-10
Glen Canyon Dam May Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

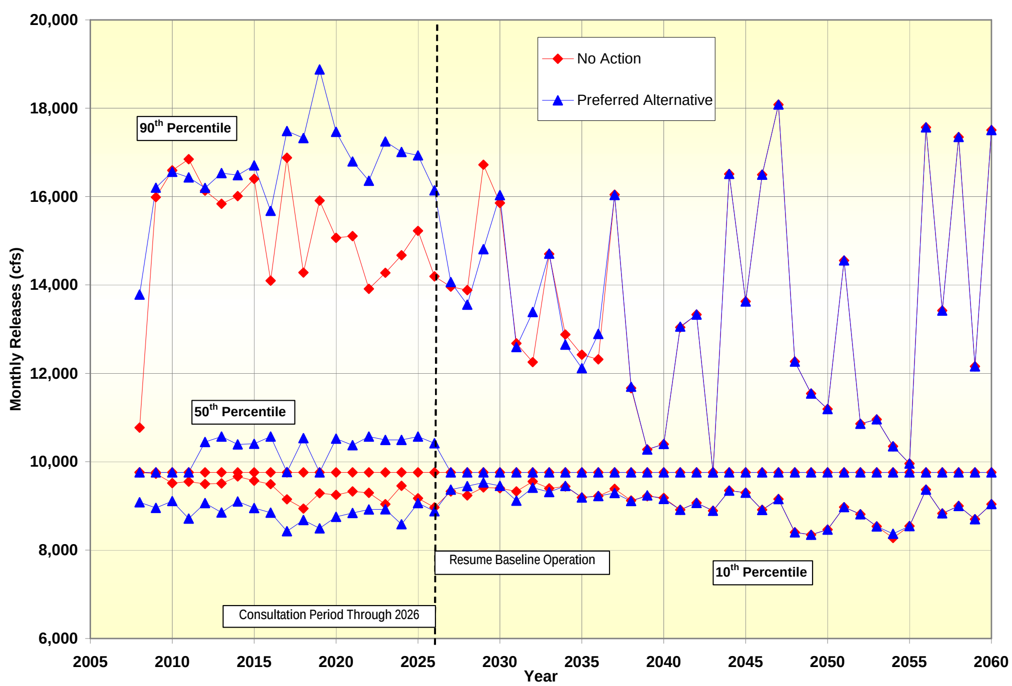

Figure BA-11
Glen Canyon Dam June Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

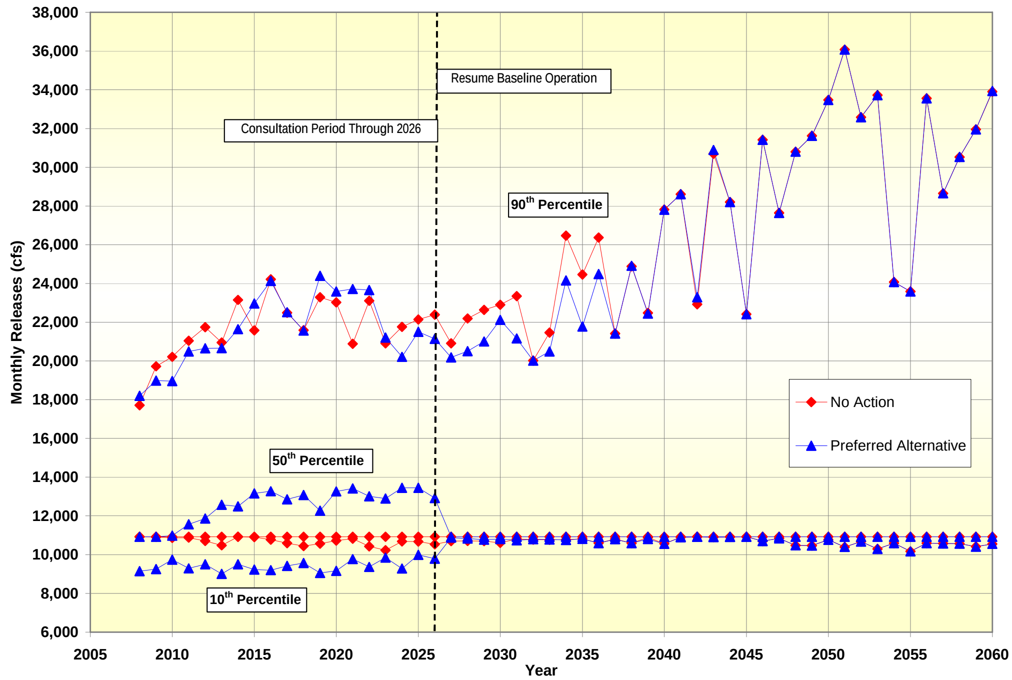

Figure BA-12
Glen Canyon Dam July Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

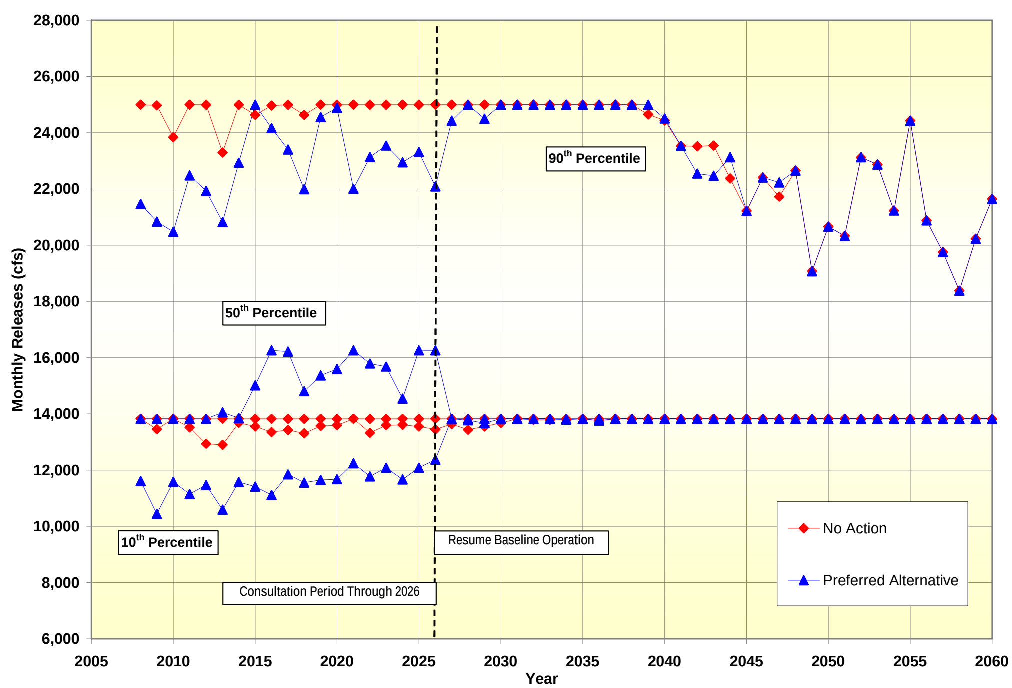

Figure BA-13
Glen Canyon Dam August Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

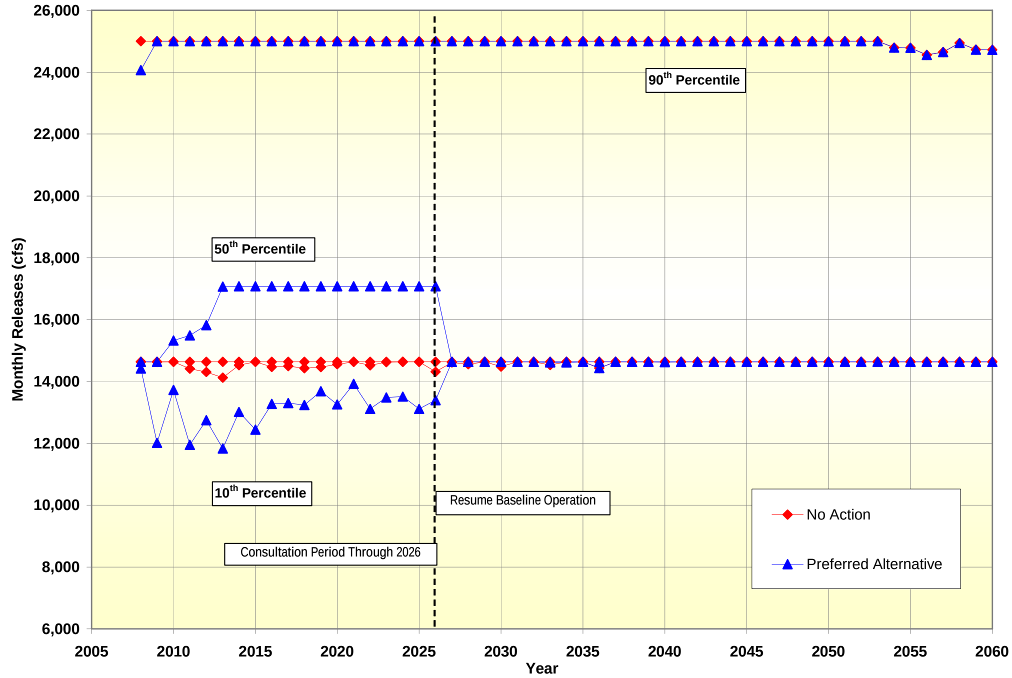

Figure BA-14
Glen Canyon Dam September Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

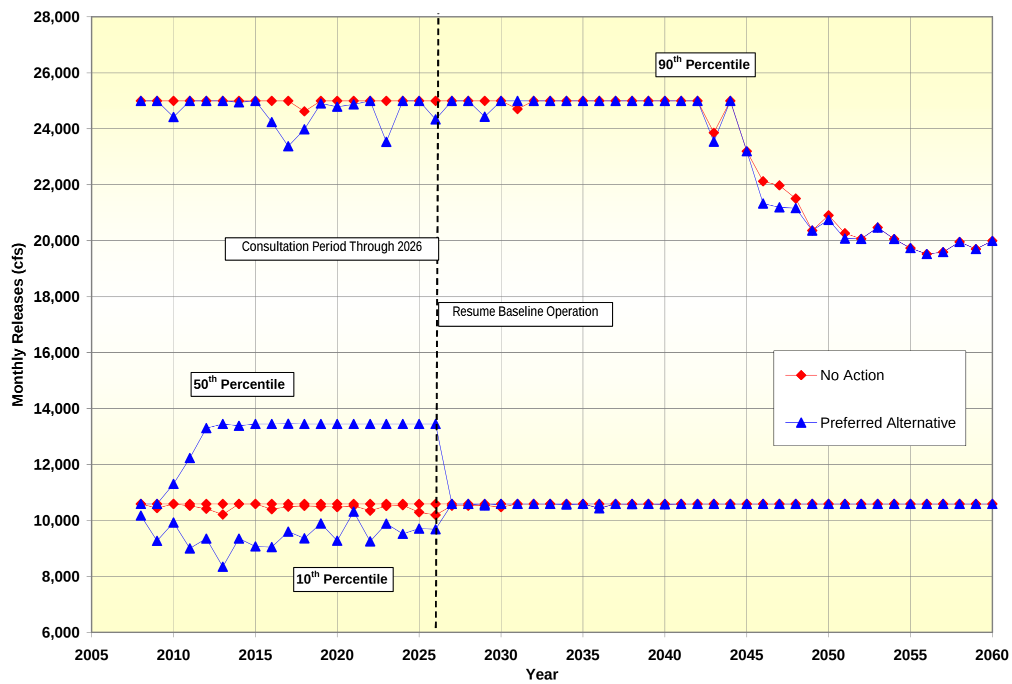

Figure BA-15
Glen Canyon Dam October Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

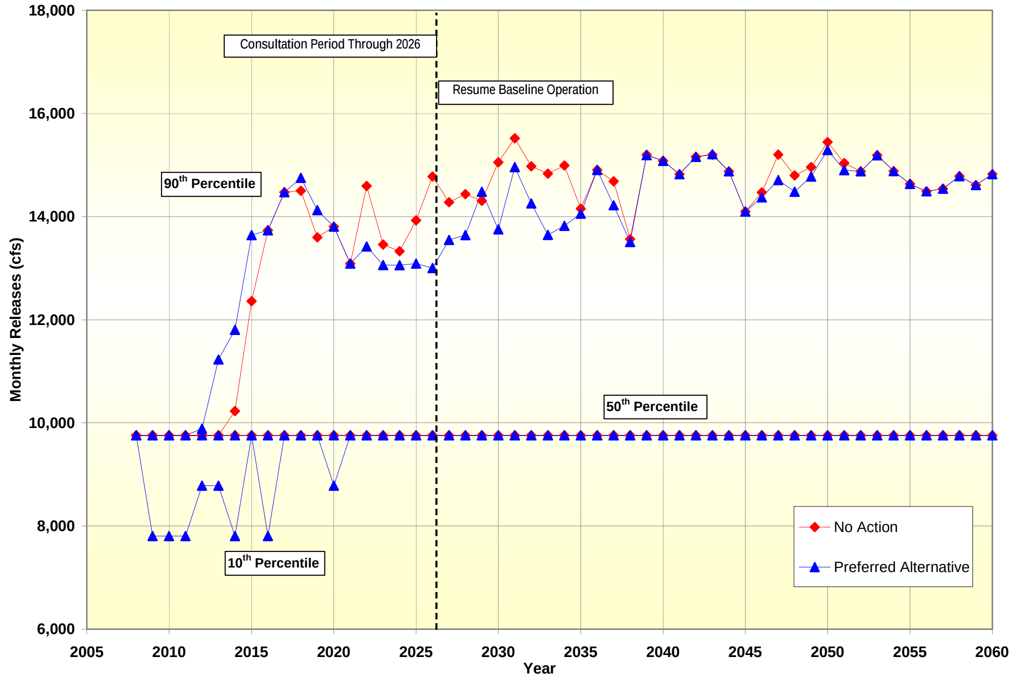

Figure BA-16
Glen Canyon Dam November Releases
Comparison of Preferred Alternative to No Action Alternative
90th, 50th and 10th Percentile Values

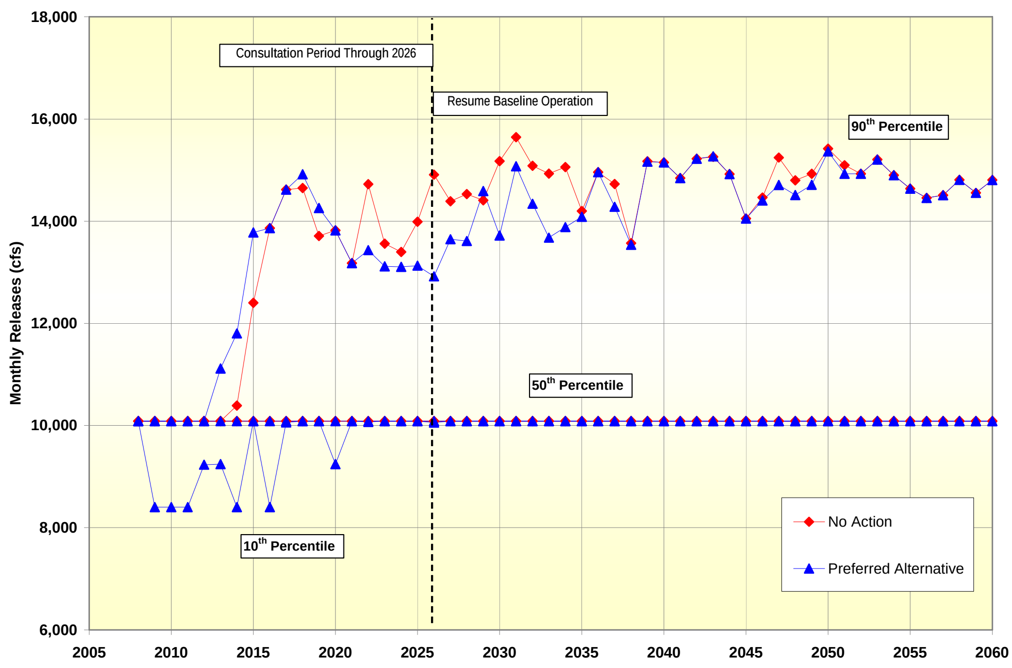

Figure BA-17
Glen Canyon Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th and 10th Percentile Values

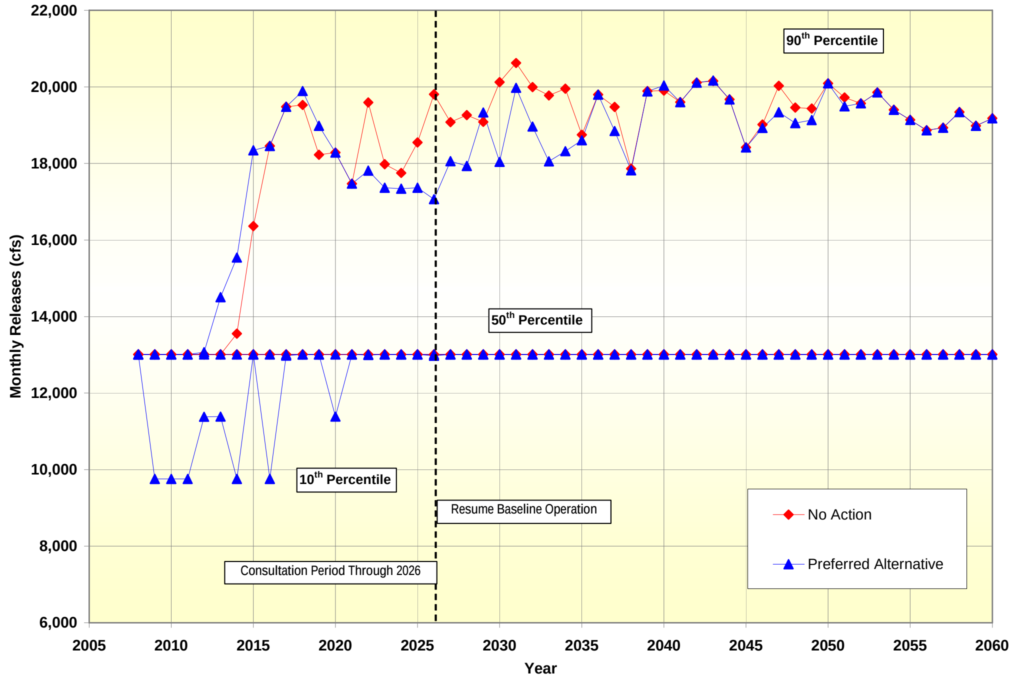

Figure BA-18
Colorado River at Lees Ferry
90th Percentile Temperatures
Upper and Lower Bound

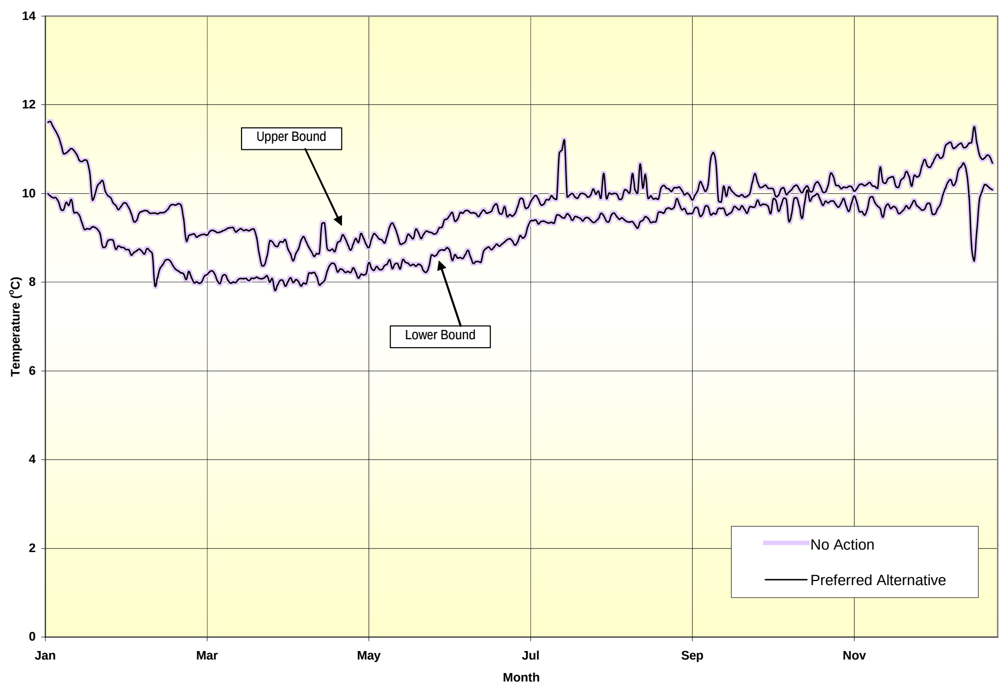

Figure BA-19
Colorado River at Lees Ferry
50th Percentile Temperatures
Upper and Lower Bound

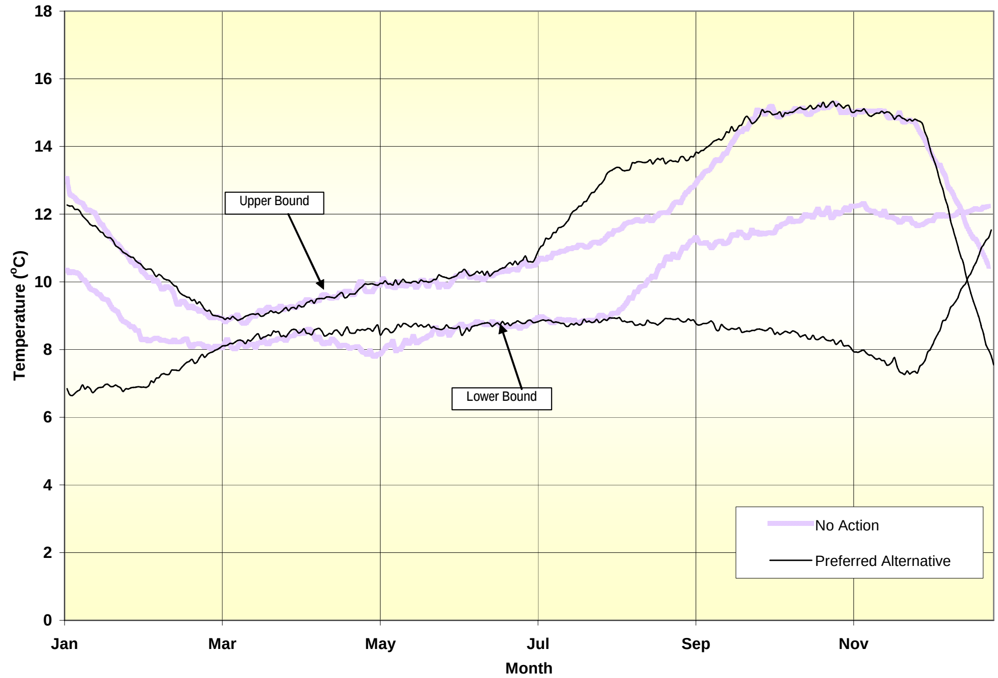

Figure BA-20
Colorado River at Lees Ferry
10th Percentile Temperatures
Upper and Lower Bound

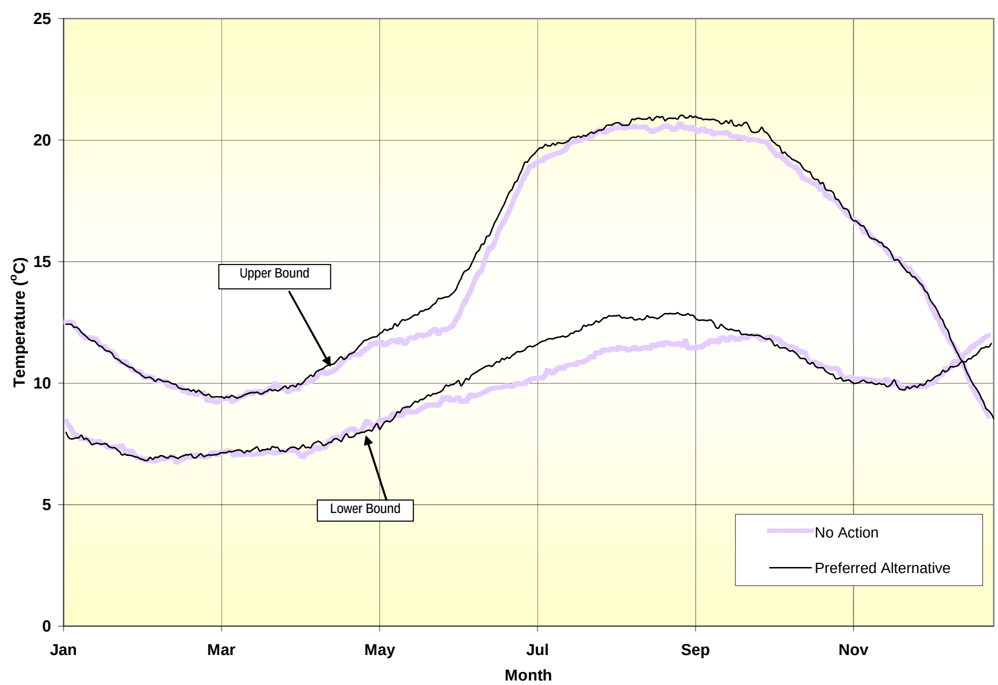

Figure BA-21
Colorado River Below Little Colorado Confluence
90th Percentile Temperatures
Upper and Lower Bound

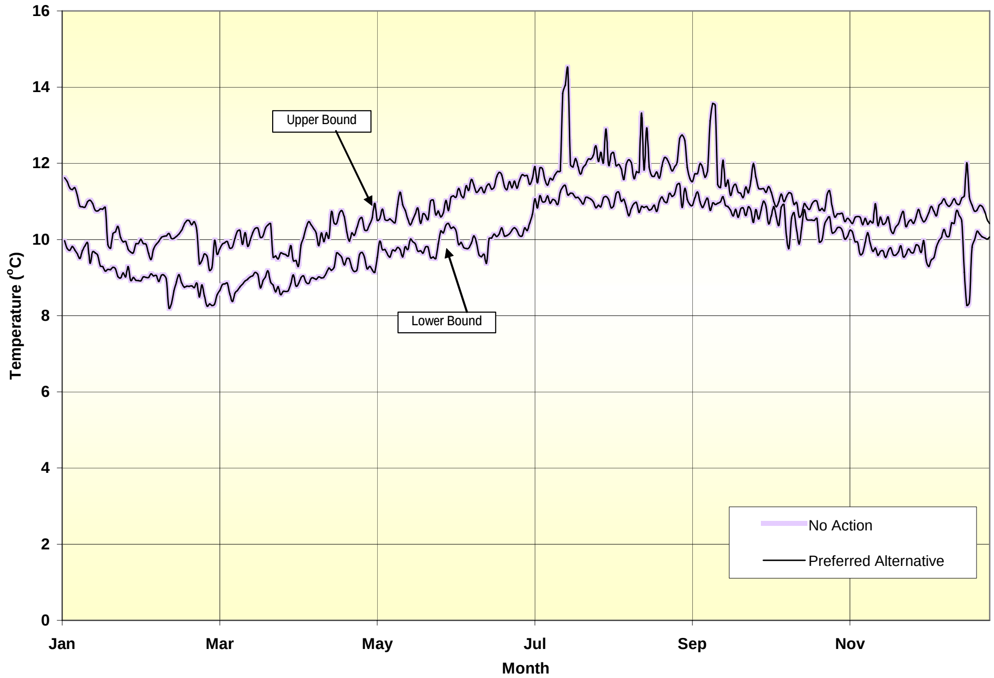

Figure BA-23
Colorado River Below Little Colorado Confluence
50th Percentile Temperatures
Upper and Lower Bound

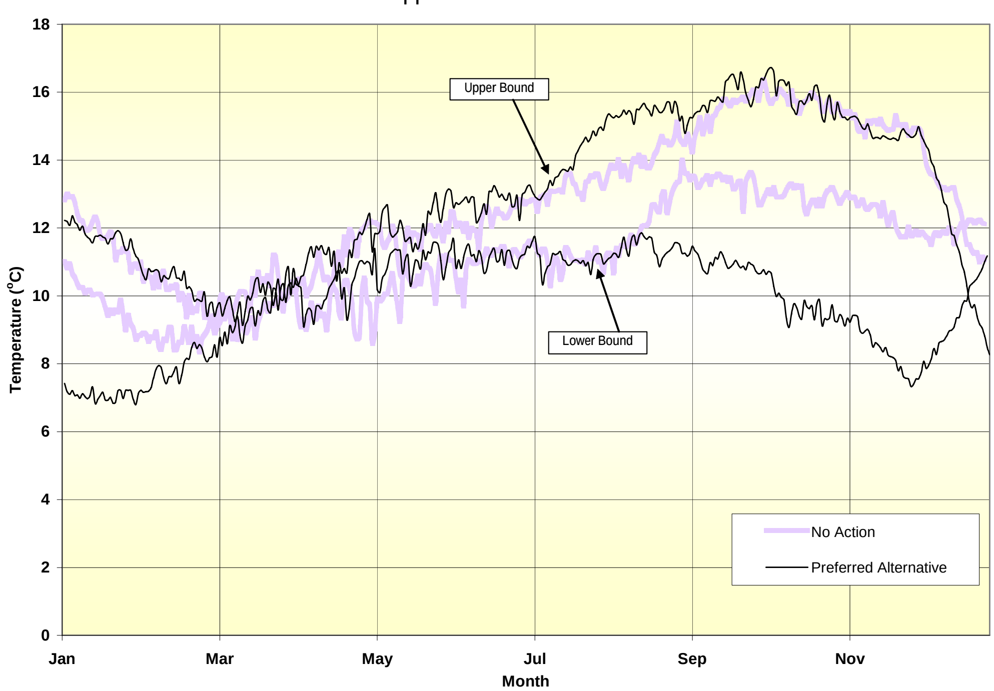

Figure BA-24
Colorado River Below Little Colorado Confluence
10th Percentile Temperatures
Upper and Lower Bound

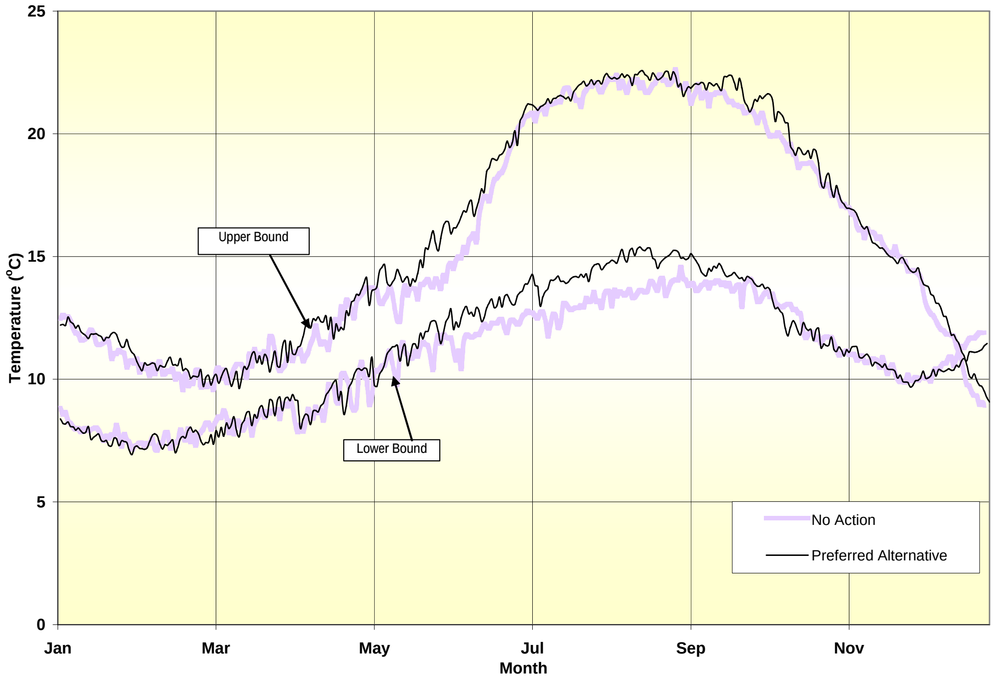

Figure BA-25
Colorado River Near Diamond Creek
90th Percentile Temperatures
Upper and Lower Bound

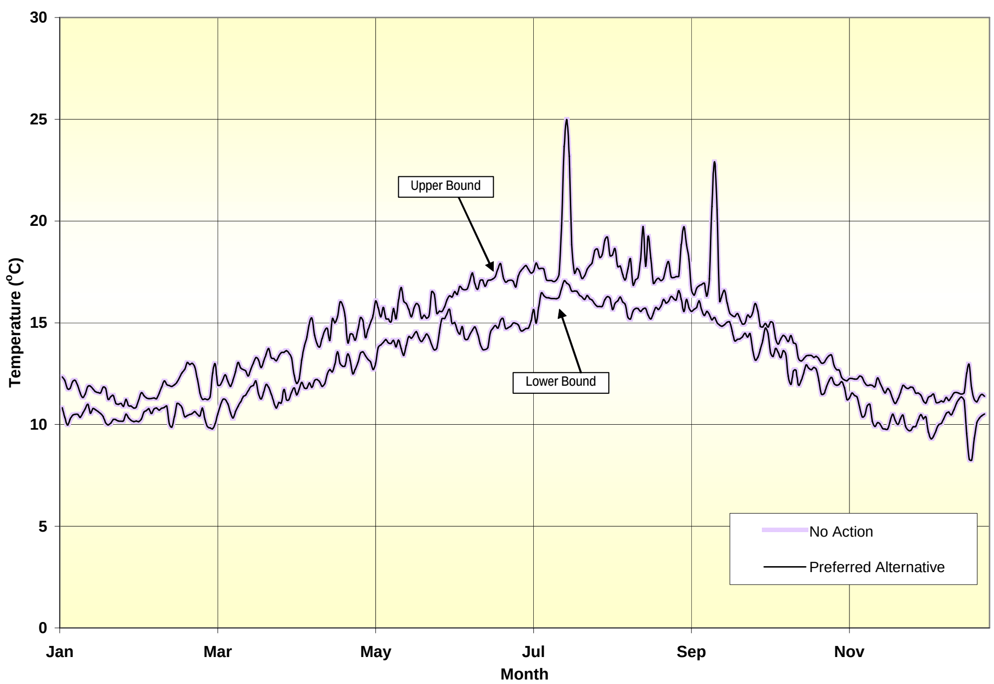

Figure BA-26
Colorado River Near Diamond Creek
50th Percentile Temperatures
Upper and Lower Bound

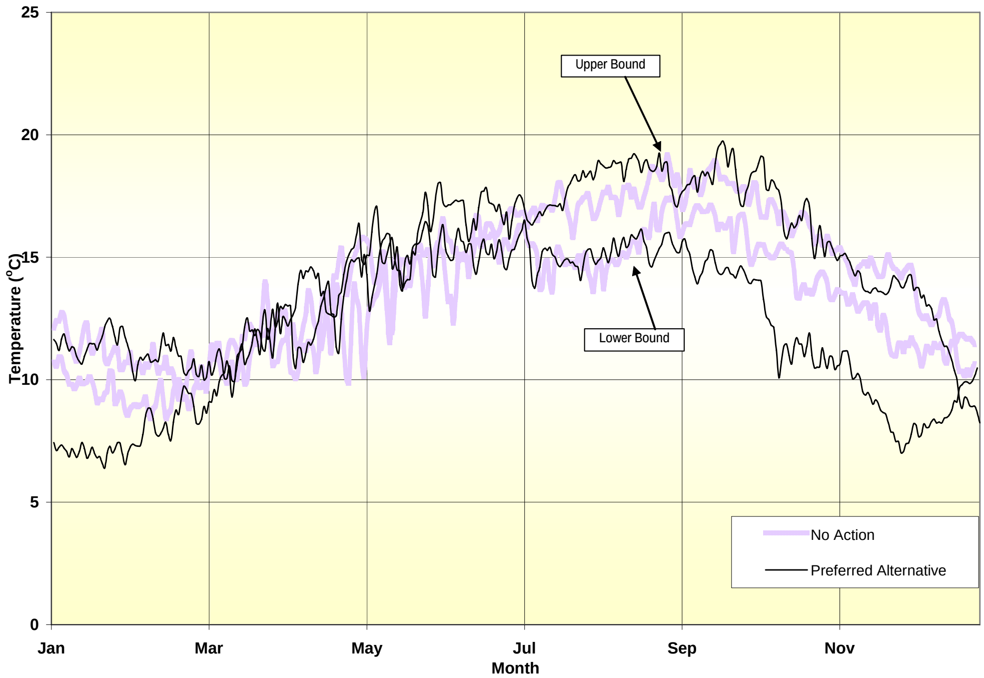

Figure BA-27
Colorado River Near Diamond Creek
10th Percentile Temperatures
Upper and Lower Bound

Table BA-1
Average Daily Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	9,758	7,806	9,758	9,758	9,758	9,758	10,775	11,518
Nov	10,083	8,403	10,083	10,083	10,083	10,083	11,048	11,806
Dec	13,011	9,758	9,758	13,011	13,011	13,011	14,309	15,094
Jan	10,759	13,011	13,011	13,011	13,011	13,824	15,286	16,654
Feb	9,724	10,804	10,804	10,804	11,704	11,704	14,722	17,347
Mar	7,319	9,758	9,758	9,758	10,571	10,571	12,376	14,634
Apr	7,563	8,403	10,083	10,083	10,083	10,924	12,127	15,226
May	7,319	9,758	9,758	9,758	10,571	13,011	11,523	15,449
Jun	9,076	10,083	10,083	10,924	13,444	15,125	14,485	22,385
Jul	11,711	13,011	13,011	13,824	16,263	17,077	16,202	22,281
Aug	11,711	13,011	13,011	14,637	17,077	17,890	19,201	24,355
Sep	7,866	10,083	10,083	10,588	13,444	14,285	17,780	22,563

Table BA-2
Minimum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	6,458	5,006	6,458	6,458	6,458	6,458	7,475	8,218
Nov	6,783	5,603	6,783	6,783	6,783	6,783	7,748	8,506
Dec	8,711	6,458	6,458	8,711	8,711	8,711	10,009	10,794
Jan	7,459	8,711	8,711	8,711	8,711	9,524	10,986	12,354
Feb	6,924	7,504	7,504	7,504	8,404	8,404	10,422	13,047
Mar	5,000	6,458	6,458	6,458	7,271	7,271	9,076	10,334
Apr	5,000	5,603	6,783	6,783	6,783	7,624	8,827	11,926
May	5,000	6,458	6,458	6,458	7,271	8,711	8,223	11,149
Jun	6,276	6,783	6,783	7,624	9,144	10,825	10,185	17,000
Jul	8,411	8,711	8,711	9,524	11,963	12,777	11,902	17,000
Aug	8,411	8,711	8,711	10,337	12,777	13,590	14,901	17,000
Sep	5,066	6,783	6,783	7,288	9,144	9,985	13,480	17,000

Table BA-3
Maximum Hourly Glen Canyon Dam Releases (cfs)
Corresponding to Various Annual Release Volumes

	7.0 maf	7.48 maf	7.8 maf	8.23 maf	9.0 maf	9.5 maf	9.5 to 11.0 maf	11.0 to 16.0 maf
Oct	12,458	10,006	12,458	12,458	12,458	12,458	13,475	14,218
Nov	12,783	10,603	12,783	12,783	12,783	12,783	13,748	14,506
Dec	16,711	12,458	12,458	16,711	16,711	16,711	18,009	18,794
Jan	13,459	16,711	16,711	16,711	16,711	17,524	18,986	20,354
Feb	11,924	13,504	13,504	13,504	14,404	14,404	18,422	21,047
Mar	10,000	12,458	12,458	12,458	13,271	13,271	15,076	18,334
Apr	10,000	10,603	12,783	12,783	12,783	13,624	14,827	17,926
May	10,000	12,458	12,458	12,458	13,271	16,711	14,223	19,149
Jun	11,276	12,783	12,783	13,624	17,144	18,825	18,185	25,000
Jul	14,411	16,711	16,711	17,524	19,963	20,777	19,902	25,000
Aug	14,411	16,711	16,711	18,337	20,777	21,590	22,901	25,000
Sep	10,066	12,783	12,783	13,288	17,144	17,985	21,480	25,000

Table BA-4
Glen Canyon Dam Water Year Releases
Probability of Occurrence of Different Water Year Release Volumes
Comparison of Action Alternatives to No Action Alternative
Water Years 2008 through 2026

Glen Canyon Dam Release Volumes	Alternative	
	No Action	Preferred Alternative
Greater than 16.00 mafy	3.63%	3.53%
Between 11.01 to 16.00 mafy	17.11%	16.42%
Between 9.01 to 11.00 mafy	14.05%	14.37%
Between 8.51 to 9.00 mafy	4.42%	22.37%
Between 8.24 to 8.50 mafy	2.74%	2.11%
Minimum Objective Release of 8.23 mafy	57.74%	31.16%
Between 7.51 to 8.22 mafy	0.21%	0.68%
Between 7.01 to 7.50 mafy	0.05%	8.11%
Less than or equal to 7.00 mafy	0.05%	1.26%
Total	100.00%	100.00%

Table BA-5
Average Monthly Temperature at Lees Ferry

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	9.5	10.5	10	9.5	10.5	10
February	9	8.7	8.5	9	8.7	8.5
March	8.5	8.3	8.2	8.5	8.3	8.2
April	8.5	8.3	8.8	8.5	8.3	8.8
May	8.7	8.9	10	8.7	8.9	10
June	9	9.2	11.5	9	9.2	11.5
July	9.5	9.5	15	9.5	9.5	15
August	10	10.5	16	10	10.5	16
September	10.3	11	16.5	10.3	11	16.5
October	10.5	11.5	15.5	10.5	11.5	15.5
November	10.3	11.5	14	10.3	11.5	14
December	10	11	12	10	11	12

Table BA-6
Average Monthly Temperature Below Little Colorado river

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	10.0	10.8	9.7	10.0	9.4	9.7
February	9.4	9.4	8.9	9.4	9.1	9.0
March	9.4	9.8	9.5	9.4	9.7	9.4
April	9.7	10.3	10.5	9.7	10.7	10.8
May	10.2	11.0	12.2	10.2	11.5	12.8
June	10.7	11.7	14.4	10.7	12.0	15.4
July	11.5	12.1	18.0	11.5	12.4	17.8
August	11.5	13.0	17.8	11.5	13.4	18.7
September	11.4	14.4	17.6	11.4	13.4	18.2
October	10.7	14.4	16.0	10.7	12.9	16.1
November	10.2	13.8	13.3	10.2	11.8	13.3
December	10.4	12.4	11.2	10.4	10.5	11.2

Table BA-7
Average Monthly Temperature Near Diamond Creek

	No Action			Preferred Alternative		
Month	90th Percentile	50th Percentile	10th Percentile	90th Percentile	50th Percentile	10th Percentile
January	10.9	10.6	9.6	10.9	9.3	9.6
February	11.2	9.8	9.3	11.2	9.6	9.4
March	12.0	11.2	11.0	12.0	11.0	10.9
April	13.4	12.4	12.6	13.4	13.2	13.4
May	14.8	14.2	15.2	14.8	15.2	16.3
June	15.8	15.5	17.7	15.8	16.1	19.1
July	17.2	16.5	20.2	17.2	16.8	20.9
August	16.8	16.6	20.7	16.8	17.1	21.6
September	16.0	17.3	20.0	16.0	16.5	20.5
October	13.4	15.6	16.9	13.4	14.5	17.2
November	11.3	13.7	13.3	11.3	11.9	13.2
December	10.8	11.8	10.8	10.8	10.1	10.7

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