Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Native Fish Augmentation Plan

2015–2020

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

September 2015

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

Arizona Participant Group

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
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City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState Local Governments Authority
Desert Wildlife Unlimited

California Participant Group

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City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
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Hualapai Tribe
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Chemehuevi Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

Lower Colorado River Multi-Species Conservation Program

Native Fish Augmentation Plan

2015–2020

Lower Colorado River
Multi-Species Conservation Program
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada
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Bureau of Reclamation. 2015. Native Fish Augmentation Plan, 2015–2020. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada.

ACRONYMS AND ABBREVIATIONS

Achii Hanyo	Achii Hanyo Rearing Station
AGFD	Arizona Game and Fish Department
Bubbling Ponds	Bubbling Ponds Fish Hatchery
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
ESA	Endangered Species Act
FY	fiscal year
HCP	Habitat Conservation Plan
ISC/SIA	Interim Surplus Criteria/Secretarial Implementation Agreement
kHz	kilohertz
Lake Mohave NFWG	Lake Mohave Native Fish Work Group
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LMFH	Lake Mead Fish Hatchery
MEFF	mobilized electronic field forms
mm	millimeter(s)
NDOW	Nevada Department of Wildlife
Overton WMA	Overton Wildlife Management Area
PIT	passive integrated transponder
Reaches 4/5	Reaches 4 and 5
Reclamation	Bureau of Reclamation
SNARRC	Southwest Native Aquatic Resources and Recovery Center
TL	total length
USFWS	U.S. Fish and Wildlife Service
Willow Beach NFH	Willow Beach National Fish Hatchery

Symbols

>	greater than
%	percent

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4 Change to Conservation Measure for the Bonytail Lower Colorado River Multi-Species Conservation Program, Program Decision Document PDD 11-003

5 USFWS Memorandum: Conclusion of 1994 Intra-Service Biological Opinion for Stocking of Rainbow Trout and Channel Catfish in the Lower Colorado River

INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-stakeholder, Federal and non-Federal partnership responding to the need to balance the use of lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act (ESA). This is a long-term (50-year) program to conserve at least 26 species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through the implementation of a Habitat Conservation Plan (HCP). Most of the covered species are State and/or federally listed special status species. The Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP Habitat Conservation Plan (Reclamation 2004) over the 50-year term of the program. A Steering Committee currently consisting of 57 entities has been formed, as described in the Lower Colorado River Multi-Species Conservation Program, Funding and Management Agreement (Lower Colorado River Multi-Species Conservation Program Steering Committee 2005), to provide input and oversight functions in support of LCR MSCP implementation. The HCP describes the implementation strategy for conservation measures to aid in the recovery of razorback sucker and bonytail through the augmentation stocking of 660,000 subadult razorback sucker and 620,000 bonytail into the LCR and its connective channels as described in the HCP. Also acknowledged in the HCP, these numbers represent a target effort for native fish augmentation in the LCR and are used "to define the extent of funding that would be available, with the understanding that the adaptive management process would guide the actual stocking program" (Reclamation 2004). Included in the numbers of fish for augmentation stockings shown above are commitments to stock at least 270,000 razorback sucker and 200,000 bonytail in LCR MSCP Reaches 4 and 5 (Reaches 4/5) (California Department of Fish and Game [CDFG] 2005).

Declines in populations of native fish, including razorback sucker and bonytail, were initially attributed to human-caused alterations to the LCR that dramatically changed the historical hydraulic characteristics of the river (Minckley and Deacon 1968; Fradkin 1981). More recent research has suggested that competition and predation from introduced nonnative fish species is the most likely factor inhibiting the persistence and recovery of these native fishes (Meffe 1985; Minckley 1991; Clarkson et al. 2005; Marsh and Pacey 2005). The conservation measures associated with native fish augmentation were included in the HCP as part of the best practices for achieving successful conservation for razorback sucker and bonytail in the LCR. Augmenting these fish populations embraces the strategy of replacing fish that are depleted due to high predation rates. In general, the smaller life stages of native fish are more likely to be depredated upon because of the number and size of the nonnative predators present. Using larger fish to augment these populations is suggested to be more effective, as the

stocked fish will be too large to be eaten by a large proportion of the predators in the system (Minckley et al. 2003; Marsh et al. 2005; Kesner et al. 2012a [C12], 2012b [D8]).

The intent of this plan is to provide the framework to achieve the conservation goals associated with augmentation stocking for the LCR MSCP as identified under the HCP for the period 2015–2020. It is not intended to be an all-inclusive conservation and management plan for native fishes in the LCR. It should instead be used as a gauge for past accomplishment and an adaptive management tool for the future; it is a dynamic document that will evolve as additional knowledge and experience is gained through research and monitoring as well as from implementation of the fish augmentation program itself. This plan has been developed within the context of the HCP in that mitigation is provided under the LCR MSCP for covered actions under the program and will "accommodate water diversions and power production and optimize opportunities for future water and power development. . ." (Reclamation 2004). This plan has also been developed under the assumption that the three State entities that are part of the LCR MSCP (California, Arizona, and Nevada) have the authority and discretion to manage wildlife populations, including nonnative fishes, within their State boundaries.

This plan is formatted so that it first provides a brief background and current status of the fish species themselves, defines the augmentation goals for the program by river reach for the LCR MSCP, and identifies the basic augmentation components and considerations necessary to effectively carry out the plan. The document then provides a current status update of the augmentation goals by reach and identifies accomplishments under the fish augmentation program since publication of the Lower Colorado River Multi-Species Conservation Program, Final Fish Augmentation Plan (Reclamation 2006). It describes how information gathered through research, monitoring, and implementation has influenced our approach to meeting the goals identified in the HCP and how this information has been incorporated to bring us to where we are today. It also details how the current state of knowledge has, in some cases, changed our approach, and it outlines the strategies for meeting our program's conservation goals through augmentation for the next 5 years.

BACKGROUND

Razorback Sucker

As of January 2015, only two wild populations of razorback sucker are known to exist in the Colorado River below the Grand Canyon. One population of approximately 600 adults occupies Lake Mead (Reach 1), and a small population (less than 50 fish) of wild fish may still remain in Lake Mohave (Reach 2)

(Albrecht et al. 2014 (*in prep.*) [D8];[1] Kesner et al. 2012a [C12], 2012b [D8]). Both populations are under active study through separate actions, and both populations have had augmentations focused on different priorities in the past. The Lake Mead population has been augmented to a far lesser extent in the past decade; augmentation efforts have been focused on providing a limited number of captive-reared fish to assist in determining distribution, assessment of habitat use, and documentation/confirmation of natural recruitment. The Lake Mohave population of razorback sucker (estimated at approximately 3,000 fish) is now predominately comprised of augmented razorback sucker (Kesner et al. 2012a [C12], 2012b [D8]). Razorback sucker populations in the lakes and river reaches downstream from Davis Dam (Reaches 3 and 4/5) are considered to be completely repatriated; populations of razorback sucker have been re-established and maintained in these reaches through past and ongoing augmentation efforts. These repatriate populations have been established over the past two decades from releases of more than 200,000 razorback sucker through cooperative efforts by State and Federal agencies. Reach 3 has an estimated population of roughly 4,500 fish (Ehlo et al. 2015 [C33]). There is currently no population estimate for razorback sucker in Reaches 4/5.

Bonytail

There are no known wild populations of bonytail in the LCR. In the past decade, it was suggested that a few wild bonytail might still remain in Lake Mohave, but attempts to locate these fish have been unsuccessful, and this possibility is considered extremely remote. Bonytail are considered to be functionally extirpated on the LCR; its persistence relies on continued augmentation (Marsh et al. 2013; Pacey and Marsh 2008 [C16]).

Stocking of bonytail into the LCR began late in 2006 and occurred each subsequent year downstream from Davis Dam in isolated ponds, connected backwaters, and in the main river channel. Stocked individuals of this species have been contacted, but these contacts are usually made soon after stocking, and establishment of an adult population has not been documented in any stocking reach (Karam et al. 2013 [C39]; Marsh et al. 2013; Pacey and Marsh 2008 [C16]). Post-stocking survival has been the highest in Reach 3; however, estimated post-stocking survival is typically less than 1 year. Bonytail stocked in Reach 3 appear to exhibit a high site fidelity to the Bill Williams River and the lower end of Lake Havasu (Karam et al. 2013 [C39]). A few stocked bonytail have been re-contacted with remote passive integrated transponder (PIT) scanners after 2 years post-release; however, these are thought to represent a limited number of individuals. Low re-contact rates were reported for bonytail released in Reaches 4/5 in 2006–07 (Schooley et al. 2008 [C8]).

[1] Brackets denote LCR MSCP work tasks.

AUGMENTATION GOALS

The target goal of the augmentation program is to provide a total of 660,000 razorback sucker and 620,000 bonytail for reintroduction into the Colorado River over a 50-year period to conserve these species and aid in their recovery. These augmentation stockings are of three types. In Type I, there are requirements to stock fish for simple population development/ maintenance, with a few thousand fish to be stocked each year for 40 to 50 years. This type of stocking is targeted for Reaches 2–5 for bonytail and Reaches 3–5 for razorback sucker. Type I stocking is intended to continue throughout the LCR MSCP's life. Stocking numbers by reach and species are detailed below. In Type II, also referred to as experimental augmentation, fish are to be released in large quantities each year for 10 consecutive years to provide research opportunities. These stockings require stocking additional fish concurrent with ongoing Type I stocking. Type II stockings are targeted specifically for Reaches 3 (razorback sucker only), 4, and 5 (razorback sucker and bonytail). Specific number goals for species within a reach are described below. Type III stocking is to complete specific actions associated with conservation measures from previous ESA consultations; these were incorporated into the program by the signing of the LCR MSCP. The native fish augmentation goals by LCR MSCP reach, as defined by the LCR MSCP Habitat Conservation Plan (Reclamation 2004) (as revised to include minor modifications, discussed later), are detailed below. The locations and boundaries for each river reach are depicted on the LCR MSCP planning area map (figure 1). A list of past stocking locations is provided in attachment 1.

Reach 1

There are no specific requirements for stocking razorback sucker in Reach 1 (Lake Mead). Any augmentation-related actions are identified as part of the Interim Surplus Criteria/Secretarial Implementation Agreement (ISC/SIA) commitments. These commitments involve capturing and rearing larval razorback from Lake Mead if water levels reach an elevation threshold during February through April for the 15 years that ISC are in place: "Should water levels reach 1,160 feet because of the implementation of the ISC, Reclamation will implement a program to collect and rear larval razorback in Lake Mead the spawning season following this determination. If larvae cannot be collected from Lake Mead, wild larvae will be collected from Lake Mohave." There are no specific numbers of larval, juvenile, or subadult razorback sucker identified as a stocking requirement for Lake Mead. There are no additional augmentation goals provided under the HCP for razorback sucker, and there are no bonytail requirements for this reach (U.S. Fish and Wildlife Service [USFWS] 2001). Reach 1 is included in this plan because of potential future conservation opportunities that may become part of LCR MSCP through the adaptive management process. The HCP provides for this flexibility in conservation efforts under conservation measure RASU1.

Figure 1.—LCR MSCP planning area, including river reach designations.

Reach 2

Razorback

The HCP provides no specific augmentation goals, with respect to total stocking numbers, for Reach 2 (Lake Mohave). Instead, augmentation goals for Reach 2 are intended to support and maintain a genetic refuge and broodstock for razorback sucker in Lake Mohave. The Lake Mohave Native Fish Work Group (Lake Mohave NFWG) has identified a broodstock population target of 50,000 adults. The HCP, under conservation measure RASU5, states: "Provide support to maintain the current Lake Mohave Program (Native Fish Work Group) goal of maintaining a population of 50,000 adult razorback sucker as a genetic refuge."

Bonytail

A total of 200,000 subadult bonytail (at least 300 millimeters [mm] total length [TL]) are to be stocked into Reach 2 of the LCR. Stockings are expected to commence by 2016 and average 5,000 subadult bonytail per year for 40 years.

Reach 3

Razorback

A total of 330,000 subadult razorback sucker (at least 300 mm TL) are to be stocked into Reach 3 of the LCR (between Davis and Parker Dams). The augmentation goals include 6,000 subadult razorback sucker stocked annually for 45 years and an additional 6,000 subadult razorback sucker as "experimental augmentation" over a 10-year period when production capacity permits. Experimental augmentations will include intensive followup monitoring.

Bonytail

A total of 200,000 subadult bonytail are to be stocked into Reach 3 of the LCR. This will be accomplished through an annual augmentation goal of 4,000 subadult bonytail for 50 years.

Reaches 4/5

The length requirement for both subadult razorback sucker and bonytail is 305 mm in Reaches 4/5 (between Parker and Imperial Dams). This difference in TL at stocking for subadult fish in these reaches has been included to be consistent with the definitions contained in the California Endangered Species Act permit (CDFG 2005).

Razorback

A total of 330,000 subadult razorback sucker (at least 305 mm TL) are to be stocked within Reaches 4/5 of the LCR. Under the HCP, stocking rates to be allocated include 6,000 razorback sucker annually for 45 years plus an additional 6,000 per year for a 10-year period for species research.

Bonytail

A total of 220,000 subadult bonytail (at least 305 mm TL) are to be stocked within Reaches 4/5 of the LCR. This will be accomplished by stocking 4,000 fish annually for 45 years plus an additional 4,000 fish per year for a 10-year period designated for intensive research and monitoring.

IMPLEMENTATION COMPONENTS

To successfully implement a fish augmentation program, there are a number of critical resources that must be secured and conditions that must be considered. The components of this augmentation program are intimately linked and may influence our strategies for implementation. The primary components of implementing the fish augmentation program are:

- Fish rearing facilities
- Broodstock
- Stocking considerations
- Monitoring and research
- Adaptive management/HCP minor modifications
- Recordkeeping and data management
- Conditions and criteria under which fish augmentation may cease
- Alternative measures to minimize and fully mitigate for authorized take in the event fish augmentation measures cease

Fish Rearing Facilities

The USFWS and the States of Arizona, Nevada, and California have mandated responsibilities for the management of fish and wildlife within the LCR MSCP project area. In addition, each State agency (Arizona Game and Fish Department [AGFD], California Department of Fish and Wildlife [CDFW], and Nevada Department of Wildlife [NDOW]) operates and maintains fish rearing facilities. LCR MSCP staff will continue to work closely with these agencies to accomplish the augmentation requirements for razorback sucker and bonytail.

An evaluation (conducted prior to implementation of the LCR MSCP) of the production capacities at existing State and Federal facilities indicated that all of the fish necessary to complete the augmentation conservation measures could be reared. Assuming that current and projected production capacity needs continue to be met by these agency-operated facilities, the construction of new fish hatcheries will not be required.

Support is currently provided under the LCR MSCP to the following facilities that rear one or more of these species or have agreed to either enter into, or to continue, a partnership with the LCR MSCP to provide rearing space for these fishes:

- Willow Beach National Fish Hatchery (Willow Beach NFH) (USFWS), Willow Beach, Arizona
- Achii Hanyo Rearing Station (Achii Hanyo) (USFWS), Parker, Arizona
- Southwest Native Aquatic Resources and Recovery Center (SNARRC) (USFWS), Dexter, New Mexico
- Bubbling Ponds Fish Hatchery (Bubbling Ponds) (AGFD), Cornville, Arizona
- Lake Mead Fish Hatchery (LMFH) (NDOW), Boulder City, Nevada
- Overton Wildlife Management Area (Overton WMA) (NDOW), Overton, Nevada

Maintenance and repair/replacement of infrastructure may be required at one or more of these facilities to develop and maintain fish rearing capabilities and/or capacities. While not a comprehensive list, these activities will include:

- Repairing/replacing solar and/or electric heating equipment
- Repairing/replacing pond liners
- Developing/repairing/replacing water delivery systems, including pipes, valves, pumps, well motors, and head-box boards
- Constructing new ponds
- Installing/repairing fish collection kettles
- Repairing/replacing bird netting and other predator control devices

- Maintaining access roads, work areas, lighting, and security systems (alarms and fences)

- Repairing/replacing backup power generators, load banks, and electric service components

Razorback Sucker Rearing Facilities

Reclamation has been working successfully since 1994 with both the USFWS at the Willow Beach NFH and the AGFD at Bubbling Ponds to develop and expand their warm-water fish rearing capabilities. The focus has been centered on refurbishing and retrofitting existing facilities. This relationship and development has continued under the LCR MSCP. Willow Beach NFH and Bubbling Ponds have both demonstrated the capability to produce 12,000 or more subadult razorback sucker per year. Achii Hanyo, a satellite hatchery of the Willow Beach NFH, also provides razorback sucker for stocking into the LCR. This hatchery typically produces smaller numbers of razorback sucker for stocking (predominantly for Reaches 3–5) because it is primarily used for rearing bonytail.

The SNARRC has also raised razorback sucker for the LCR MSCP, usually between 500 and 1,000 fish, and routinely produced 3,000 to 5,000 razorback sucker fingerlings for distribution throughout the Southwest. The SNARRC also provided 500 mm fish for stocking into Lake Mohave in response to a request from the Lake Mohave NFWG. The SNARRC currently maintains a broodstock of razorback sucker developed by the USFWS from Lake Mohave offspring. After the discovery of quagga mussels in the LCR in 2007, this broodstock became the sole source of razorback sucker for distribution to Bubbling Ponds to prevent the potential spread of quagga mussels to other watersheds. The SNARRC provides larval fish from their razorback broodstock to Bubbling Ponds for grow-out and future stocking into the LCR. Beginning in 2015, the SNARRC will no longer provide subadult razorback sucker for stocking into the LCR; the space made available by this change in focus will be dedicated to an increase in bonytail production to satisfy the needs of the LCR MSCP. Specifically, additional bonytail production will be needed for experimental stocking efforts (Type II) as described later in the "Status of Fish Augmentation Program and Future Augmentation Strategies" section of this document.

The NDOW's Lake Mead Fish Hatchery has recently undergone major renovation and now has a portion of the facility dedicated to rearing native fishes. The LMFH has begun to provide small numbers of razorback sucker for the LCR MSCP and is expected to produce 2,000 fish toward annual augmentation goals beginning in 2015. The Overton WMA rears razorback sucker for the

LCR MSCP. The site is also managed by the NDOW and has managed ponds used for the additional grow-out of razorback sucker. These fish represent a portion of the LMFH contribution to the LCR.

Production at all of these facilities has been increased to meet the augmentation goals as defined in the HCP. In years 2011 through 2014, the total fish stocked into the LCR main stem and backwaters along the LCR from these facilities combined has equaled or exceeded 25,000 subadult razorback sucker per year.

Other backwater ponds along the LCR are also used for additional grow-out of razorback sucker that may have been initially reared in one of the hatcheries mentioned previously (similar to the ponds in the Overton WMA). These grow-out ponds have included (or may include in the future) lakeside backwaters on Lake Mohave, existing disconnected backwaters along the LCR, and golf course ponds. Created LCR MSCP backwaters may also provide opportunities for additional grow-out of razorback sucker for augmentation; however, this is not the primary purpose of these backwaters, and their contribution to actual augmentation numbers is not expected to be large. Grow-out ponds are typically used temporarily to increase the size of fish that have been initially reared in a hatchery. They also help provide space needed in hatcheries for rearing the next cohort of fish.

Bonytail Rearing Facilities

Four facilities currently rear bonytail (or have bonytail on station) for stocking into the LCR for the LCR MSCP: the SNARRC, Willow Beach NFH, Achii Hanyo, and LMFH. The SNARRC maintains the only bonytail broodstock in the world and produces all larvae, fry, and fingerling fish for the other three sites. In addition, it rears the majority of subadult bonytail for the LCR MSCP for annual stocking into the LCR. In 2014, an additional four ponds were constructed at the SNARRC to accommodate the additional production goals for the LCR MSCP. Willow Beach NFH typically receives bonytail larvae and fry from the SNARRC and rears them to fingerling stage for distribution and further grow-out at Achii Hanyo for eventual stocking into the LCR. The LMFH had previously only held bonytail on station for short periods, until late in 2013, when approximately 56,000 juvenile bonytail were donated to the LCR MSCP from the Wahweap State Fish Hatchery in Big Water, Utah. The LMFH is currently rearing those fish for research and stocking purposes and will continue to rear bonytail for future stocking into the LCR.

Other Rearing Facilities

Additional rearing facilities have been evaluated for their potential to contribute to the LCR MSCP fish augmentation program. In 2006, LCR MSCP staff and the USFWS began work at Uvalde National Fish Hatchery in west Texas to determine the capability of this site for rearing razorback and bonytail and for other research opportunities. The pursuit of this facility for use under the LCR MSCP was discontinued in 2010 due to detections of largemouth bass virus as well as infrastructure and logistical issues. Additional facilities have also been considered primarily for additional production of bonytail in anticipation of increased program augmentation goals. The Wahweap State Fish Hatchery was recently considered as one of those facilities. The cost of hatchery expansion to accommodate additional production and the expected slow growth rate of bonytail at this location raised concerns regarding the cost-benefit of selecting this facility for LCR MSCP needs. There is still potential; however, we are not currently pursuing a partnership with this facility.

The USFWS has developed a second bonytail broodstock that is currently housed at the SNARRC in Dexter, New Mexico. The USFWS expects to relocate this additional broodstock to provide redundancy and a safeguard against loss in the event that one of these broodstocks is compromised. The LCR MSCP will help support the relocation and maintenance of the additional broodstock. Although the new location has not been determined (at the time of drafting this document), there may be an opportunity for additional bonytail production for LCR MSCP augmentation goals in the future.

Broodstock

The LCR MSCP fish augmentation program cannot be accomplished without substantial broodstocks of razorback and bonytail. These broodstocks must be of sufficient quantity and quality to produce fish for the life of the program. Quantity and quality factors include considerations of general health, reproductive vigor, and genetic makeup. Genetic considerations, in particular, are critical to ensure adequate genetic diversity of the offspring produced and to guard against genetic swamping or bottle-necking. The development and/or maintenance of broodstocks for each of the two fishes will be supported under the LCR MSCP through the fish augmentation program.

The Lake Mohave population of razorback sucker has been recognized as the most diverse genetic stock of this species. The Lake Mohave NFWG was organized in 1989 for the sole purpose of rebuilding and maintaining this broodstock, with goals of restoring the population size to 50,000 adult fish (Mueller 1995).

This genetic broodstock will be maintained under the LCR MSCP through the collection and rearing of naturally spawned larvae from Lake Mohave. After larvae have been reared to subadult size in captivity, their progeny are stocked back into Lake Mohave. Larvae collections from Lake Mohave also provide the stock for razorback augmentation in other locations on the LCR. A generalized fish production routing scheme for the Lake Mohave broodstock is illustrated on figure 2a. The systematic process for larvae collection includes the capture of larval suckers from spawning areas each spring; the lake is divided up into different spawning zones, and quotas for larvae are set per zone, per month from January through April. Over 800,000 larvae have been collected from Lake Mohave since the Lake Mohave NFWG began. More than 100,000 juvenile and subadult razorback have been repatriated into Lake Mohave from 1992 through 2005 (attachment 2). An additional nearly 100,000 subadult razorback have been stocked into Lake Mohave from 2005 through 2014 under the LCR MSCP fish augmentation program.

Using remote sensing, the repatriate population for Lake Mohave was estimated at 3,284 individuals in 2013 (Wisenall et al. 2015 [D8]). This represents approximately 1.5 percent (%) of the total fish stocked since 1992. Nevertheless, genetic diversity remains consistent with the original founder population of razorback documented in the early 1980s (based on mitochondrial DNA analyses). More recent microsatellite analyses have further supported the conclusions of the mitochondrial analysis (Dowling et al. 2014). Efforts by the Lake Mohave NFWG, and under the LCR MSCP fish augmentation program, have been successful in maintaining and conserving the genetic diversity of this broodstock so far, but because the population size is small, there is still concern for loss of genetic diversity from stochastic events.

As described earlier, in 2007, quagga mussels were found in Lake Mead and subsequently were also found in Lake Mohave. The presence of this exotic invasive species has impacted the delivery of native fish outside of the LCR. Razorback sucker larvae that were captured on Lake Mohave and delivered to Bubbling Ponds and the SNARRC for final grow-out to target size are no longer routed to those facilities. The SNARRC maintains a broodstock of razorback sucker that it utilizes to supply quagga-free larvae to Bubbling Ponds since 2007. A generalized fish production routing scheme for the SNARRC broodstock is illustrated on figure 2b.

The USFWS maintains the only broodstock for bonytail at the SNARRC. The original stock (parents of current brood fish) included fish collected from Lake Mohave from 1975 to 1985. The SNARRC has developed a captive management strategy that establishes protocols for annual bonytail production

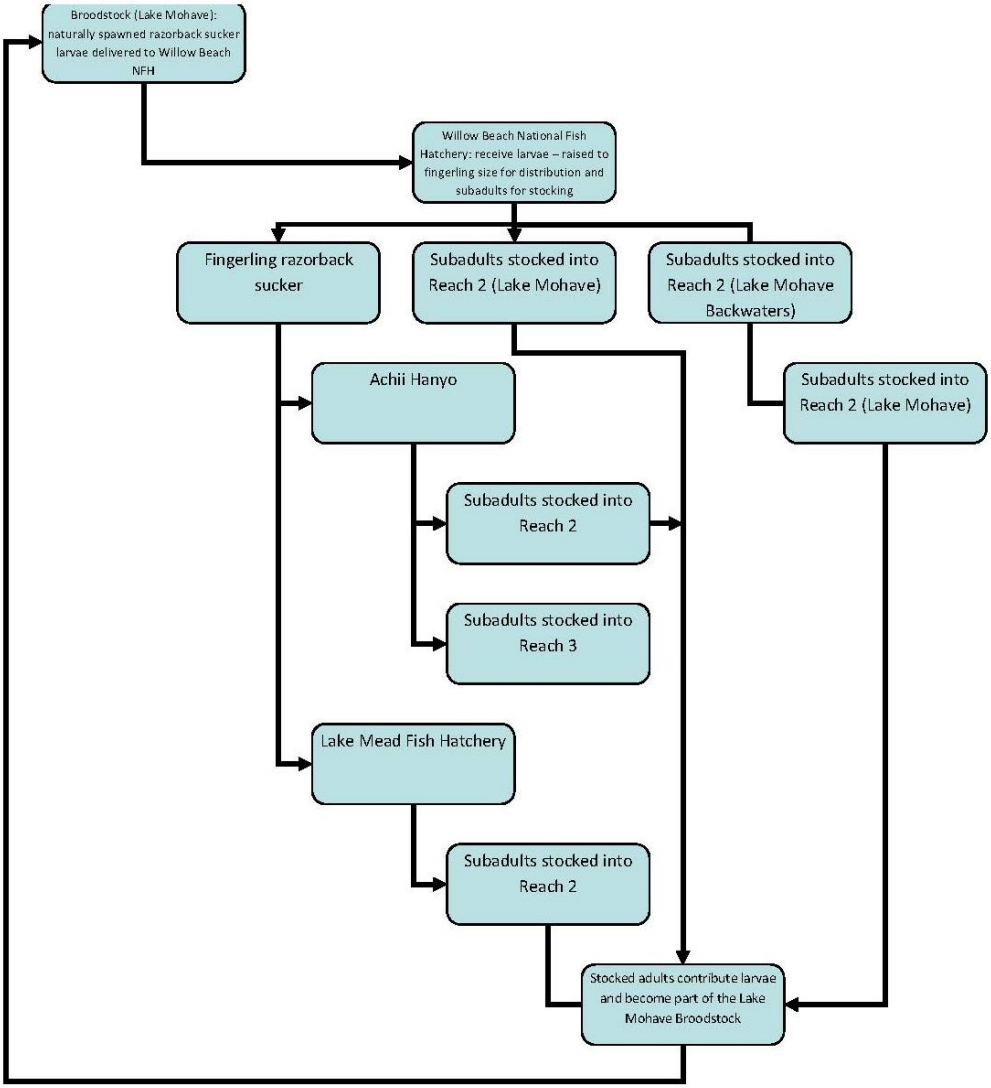

Figure 2a.—Razorback production routing; Lake Mohave broodstock.

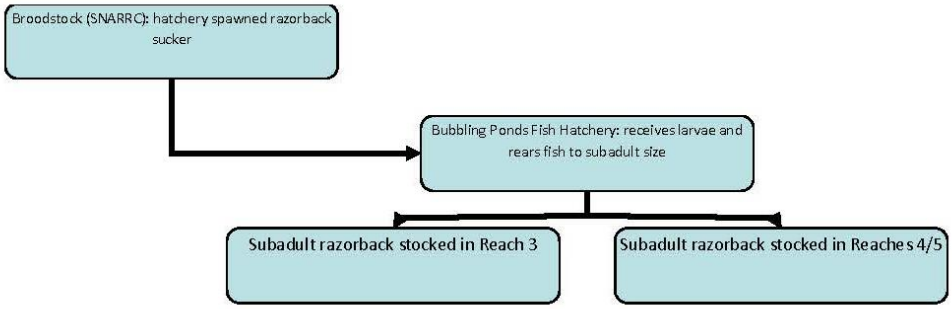

Figure 2b.—Razorback production routing; SNARRC broodstock.

Figure 2.—Razorback production routing.

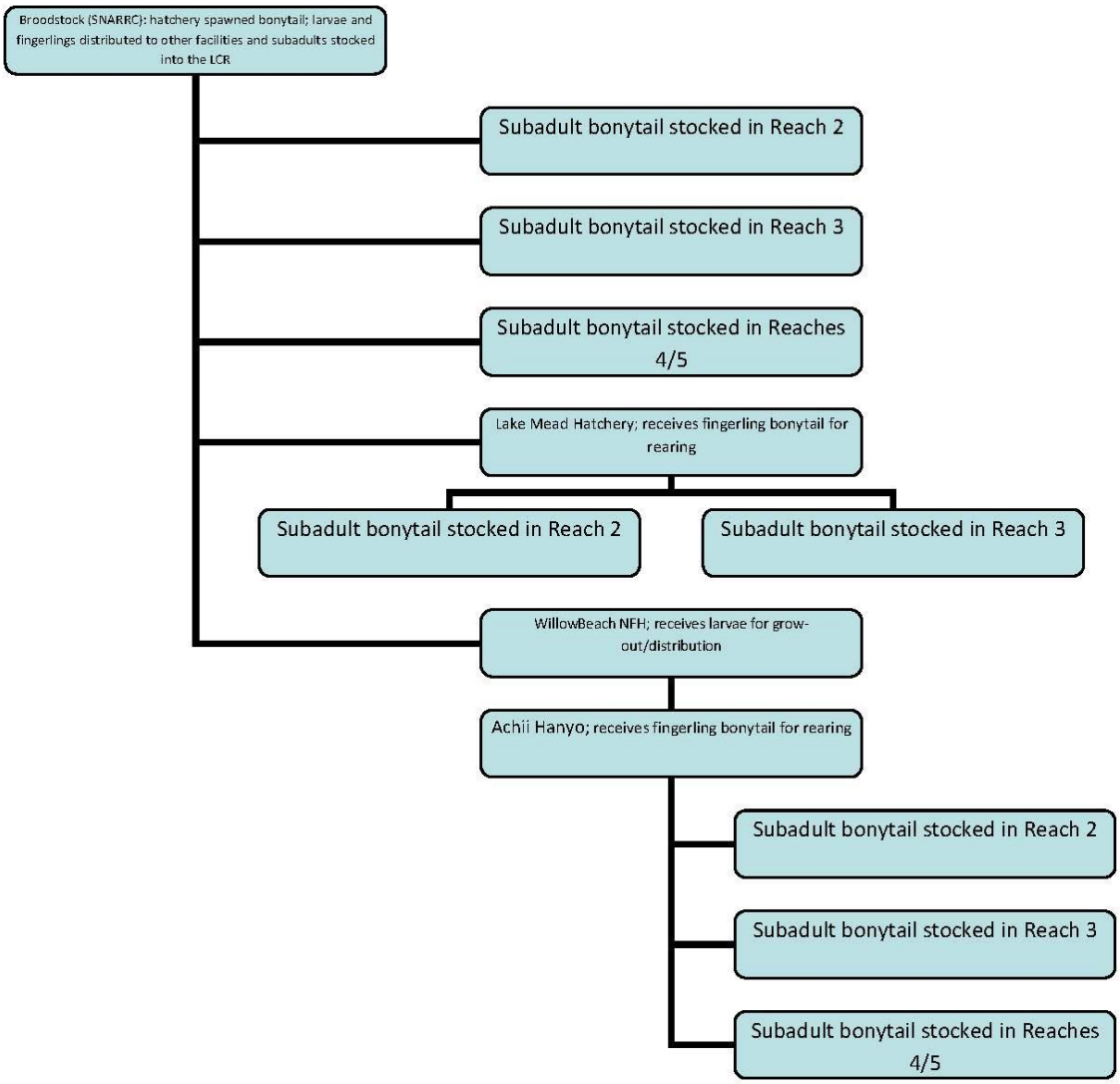

Figure 3.—Bonytail production routing.

to ensure maximization of genetic diversity through time. Bonytail are hand spawned each year; fry, fingerling, subadults, and adults are subsequently distributed throughout the Colorado River basin. A generalized bonytail production routing scheme for the SNARRC broodstock is illustrated on figure 3.

STOCKING CONSIDERATIONS

Stocking considerations are the biological and physical constraints, as well as other logistic realities, that must be acknowledged to adequately plan for any augmentation program and to maximize survival of the stocked fish. These include: 1) season of release, 2) marking and tagging requirements, and 3) handling, acclimation, and/or conditioning of fish.

Season of Release

Due to extreme air and water temperatures during the summer along the LCR, routine stocking of razorback sucker and bonytail will generally be limited to September through April. Stocking of razorback sucker and bonytail into Lake Mohave (Reach 2) may be accomplished during the summer months by putting fish from the Willow Beach NFH into the upper reaches of the lake where water temperatures stay cold due to hypolimnetic water releases from Hoover Dam.

Tagging Requirements

To provide information for an effective adaptive management program, all fish have been marked by LCR MSCP staff in some way prior to stocking. In order to estimate population sizes and assess the effectiveness of stocking techniques, locations, and treatments, recaptured fish need to be uniquely identified. All razorback sucker stocked into Reach 2 receive PIT tags. In the past, bonytail stocked in Reach 2 (by the USFWS) and razorback sucker and bonytail stocked into Reaches 3 and 4/5 were wire tagged upon initial release and only PIT tagged when they were recaptured. Advancements and expansion of PIT tags and PIT scanning technology has altered this practice, and the augmentation program has continued to keep pace with these advancements. Earlier in the program, fish released into the LCR were tagged with 400-kilohertz (kHz) PIT tags (Lake Mead and Lake Mohave, Reaches 1 and 2), 125-kHz PIT tags (Davis Dam to Parker Dam, Reach 3), and wire tags (Davis Dam to Imperial Dam, Reaches 3, 4, and 5). Recaptured fish below Parker Dam have been retagged with 125-kHz PIT tags.

Beginning in 2006, new 134.2-kHz frequency PIT tags have been used under the LCR MSCP. These new tags have a greater detection range than the previously used tags (12 inches versus 2 inches away from fish) and allow for testing and deployment of remote scanning stations within spawning areas and other locations on the LCR. Because re-contact rates are generally low, every fish stocked provides important information. Currently, every attempt is made to tag all fish with 134.2-kHz PIT tags. This practice has recently been reaffirmed as a directive of our augmentation program, and we expect to continue to PIT tag every fish stocked for the foreseeable future. The use of PIT scanning technology has been instrumental in providing data to feed back into our adaptive management program. Specifically, this technology has increased the precision of our population estimates and has helped in the discovery of new populations of native fish. This information has, in turn, influenced changes and improved fish augmentation strategies (Kesner et al. 2012b [D8]).

Other tags have also been used and may continue to be used when appropriate. Fin clipping and spaghetti tags (or Floy tags) have been used for short-term survival studies in some rearing and grow-out ponds. Some fish stocked throughout the LCR occasionally receive radio tags or sonic tags in addition to PIT tags to facilitate specific research protocols. These are typically shorter-term tags and are used for specific research or monitoring purposes. Use of tags for re-contacting, identifying, and tracking native fish will be a major component of the fish augmentation program. Tagging requirements will continue to evolve, and their use will be evaluated through the adaptive management program.

Handling, Acclimation, and Conditioning

Research continues to suggest that handling protocols are an important consideration for the post-stocking survival of native fishes. These studies indicate that handling procedures associated with stocking, such as crowding, tagging, net entanglement, prolonged exposure to air, and hauling, can increase stress levels in these fishes. Additional factors, including water temperatures and multiple handling procedures without a recovery period, can exacerbate this effect (Montony 2008; Sykes 2013). If stress levels are elevated high enough, the result can be immediate or delayed, direct and indirect (increased susceptibility to predation post-stocking) mortality. Where possible, the hatcheries used under the LCR MSCP for rearing native fish have begun to employ best practices to minimize handling stress.

Acclimation after stocking also appears to be important for native fishes. Native fishes stocked directly from a hatchery truck into the LCR have been observed to commonly bolt downstream. When acclimated in a net pen or backwater for as little as 2 or 3 days, these fish tend to more casually distribute themselves into adjacent river habitats both above and below the stocking site (Golden et al. 2006;

Mueller et al. 2003). Based upon this knowledge, fish are released by LCR MSCP staff predominantly into backwater habitats in riverine sections of the LCR. On Lake Mohave, fish are released in shoreline areas near weed beds to provide areas with cover so fish can rest and acclimate to ambient conditions.

Conditioning refers to pre-stocking treatments applied to hatchery fish that are intended to improve fitness and increase post-stocking survival. Two conditioning treatments that are being explored under the LCR MSCP include: 1) exercising fish using induced flows and 2) conditioning fish to avoid predators. These treatments are still in the preliminary stages of testing and are discussed in more detail in the "Monitoring and Research Considerations" section below.

MONITORING AND RESEARCH CONSIDERATIONS

Monitoring and research are required components of the HCP and are key elements of the adaptive management program (described below). The intent of monitoring and research for the fish augmentation program is to provide information for the adaptive management process so that we can, in turn, improve our effectiveness and efficiency in fulfilling the conservation goals associated with the fish augmentation program as described in the HCP.

Research and monitoring efforts for the fish augmentation program fall into three general focus areas: 1) determining key environmental correlates affecting growth and survival during rearing, 2) understanding and minimizing adverse effects of transporting and stocking, and 3) understanding post-stocking distribution and survival. Accordingly, the majority of our research questions and associated monitoring for the next 5 years will focus on evaluating pre-stocking handling and fitness treatments of fish as well as post-stocking use of habitat, dispersal, survival, and genetic integrity of stocked fish. A more detailed selection of ongoing and proposed research and monitoring activities is presented by reach in the "Status of Fish Augmentation Program and Future Augmentation Strategies" section below.

Stocking the appropriate number of native fishes into the LCR allows us to meet the augmentation goals of the HCP; however, survival of these stocked fish is our simplest measure of conservation success. We observe, record, and analyze survival rates during the rearing process and after fish are stocked. Monitoring is how we track survival rates of the fish we are rearing and stocking for the augmentation program. Through research, we attempt to answer "why" survival rates aren't higher and "what" the significant sources of mortality might be. Mortality is common both in the rearing process/hatchery setting and in the environments where fish are released (Wisenall et al. 2015 [D8]). We have no control, or only limited control, of many of these sources of mortality. Augmentation-directed research is employed to identify these sources of mortality

and to suggest solutions that we may be able to exploit to control or mitigate through adaptive management. This may include changes in handling protocols, stocking locations or timing, stocking batch sizes, fish stocking size, or a number of pre-stocking treatments of fish. This research may also help us to define more realistic expectations for the success of the fish augmentation program by better identifying sources of mortality that are beyond our control.

Research and monitoring efforts for augmentation have helped to continue to identify sources of mortality, and we are testing ways to increase native fish survival. Through pre-stocking research and monitoring, we continue to audit the rearing and stocking processes to identify and reduce sources of handling stress that may lead to mortality (Montony 2008; Sykes 2013). This research has resulted in the development of a number of handling protocols that, when possible and appropriate for each specific facility, are being employed at hatcheries that rear razorback sucker and bonytail for the LCR MSCP. Post-stocking research and monitoring has been focused on finding better ways to stock native fish and investigating ways to provide more "fit" fish for stocking into environments where a suite of nonnative predators exist. The former approach includes looking at factors such as day versus night stocking, using different batch sizes for stocking, and stocking in particular areas that may have more appropriate cover or fewer available predators of native fish. The latter approach focuses on fitness, in particular, flow, and predator conditioning.

Flow conditioning is a process in which an induced flow is introduced into a hatchery raceway for a period of time. This causes fish to swim to maintain their position in the water column and actively acquire food items. Preliminary laboratory research indicates that these treatments do increase swimming stamina as well as growth rates and food-conversion efficiency (Senger and Sjöberg 2010, 2011 [C26]). The hypothesis is that this increased physical fitness may allow stocked fish to better avoid predation through increased flight speed and endurance. Predator conditioning is a process in which hatchery-reared fishes, naïve to predators, are exposed to their own alarm pheromone concurrent to having a visual exposure to the predator. Preliminary laboratory results are promising: increased survival rates for conditioned fishes compared to unconditioned fishes (O'Neill and Stewart 2014 (*in prep.*) [C10]). Paired releases of both of these types of conditioned fish will help assess whether these treatments can translate to increased survival of stocked native fishes.

Stocked native fishes are extremely important for the conservation efforts of the LCR MSCP; they are intended to augment and sustain, and potentially increase existing populations. Quality, as well as quantity, of these fishes is therefore critical, and accordingly, a larger investment is made to produce quality fish. Quality can be coarsely defined as both the genetic makeup and physical health of stocked fishes. Genetic quality can be assessed by monitoring the genetic diversity of the native fish broodstocks and by collecting genetic samples from stocked fishes. Directed genetic research continues to help answer the question of

how to maximize and conserve genetic diversity in our augmentation program, and through adaptive management, it has helped to guide collection, rearing, and stocking procedures (Work Tasks C31 and C40).

Research and monitoring efforts intended to improve augmentation success also have ancillary benefits for other conservation actions under the LCR MSCP. Information gathered from monitoring/tracking stocked fish has provided insight for habitat selection and use. Specifically, in Reach 1 (Lake Mead) razorback sucker move into deeper waters in summer and fall but use shallower waters in winter and spring (Albrecht et al. 2008 [C13], [D8]). Similar patterns of seasonal habitat use have been reported for razorback sucker in portions of Reach 3 (Wydoski and Lantow 2013 (*in press*) [C45]). This combination in use of shallows with cover and appropriate deeper areas has influenced the design and creation of backwaters under the LCR MSCP restoration program in projects such as the Mojave Valley Conservation Area (E35). Appropriate spawning substrates are also typically incorporated into the design and construction of backwaters; the information to guide this practice has come from observing and characterizing habitat features that razorback sucker select as spawning grounds in the LCR as part of the monitoring of stocked fish. Other habitat features, such as types of natural or artificial cover, may be important to include in created backwaters or to consider when choosing stocking locations for both razorback sucker and bonytail. These investigations are occurring under Work Task C63.

Similarly, other portions of the conservation program can provide feedback to help the augmentation efforts. This includes research on flannelmouth sucker and their observed use of habitats in Reach 3 (C53) to provide insight into how to better improve survival for razorback sucker where habitat use and behavior appear to overlap in these species. Research conducted in the created backwaters under the LCR MSCP may help augmentation efforts by providing smaller "closed systems" where stocked fish can be more easily tracked and where certain variables can be controlled. In this way, we may be able to identify the more important sources of mortality on stocked fish and focus on trying to prevent or control these when stocking fish into the LCR for the augmentation program.

Regular monitoring through continuous sampling under the LCR MSCP, as well as annual interagency sampling efforts, will provide data on the populations of stocked fish. These data provide insight to the success of our augmentation strategies and may alert us to new challenges in the future. These monitoring efforts are critical and, in some form, are expected to continue throughout the 50-year term of the LCR MSCP. The results of all these monitoring and research efforts are provided in annual reports, research reports, and accomplishment summaries, as appropriate, and are posted to the LCR MSCP Web site when completed.

Extensive monitoring of these stocked fish is a commitment under the LCR MSCP. As provided in the augmentation goals of the HCP (amended

through minor modifications approved by the LCR MSCP Steering Committee with concurrence from the USFWS), a total of 120,000 razorback sucker and 40,000 bonytail will be made available over a 10-year period for extensive species monitoring and research. This focused monitoring/research will be targeted to provide species' life history information and to assist in developing and refining augmentation strategies.

ADAPTIVE MANAGEMENT

Adaptive management is a central implementation component of the LCR MSCP and is a critical process employed in the fish augmentation program. Adaptive management allows us to make conscious and sound changes through a formalized process that evaluates the quality and certainty of information and suggests appropriate adjustments within the context of program requirements, logistic constraints, and budgetary thresholds. Research and monitoring, as discussed in the previous section, are key components that drive the adaptive management process. This process can, and has, occurred at many levels of implementation of the fish augmentation program and has ranged from changes in sampling protocols, to adopting new technologies, to adjustments in hatchery handling protocols.

Under the adaptive management program, flexibility is also provided to assess the effectiveness of current strategies and make appropriate changes in order to improve performance and achieve success. This can also occur at the HCP level by allowing conservation measures to be adjusted over time based on the results of monitoring and research. This has occurred in the fish augmentation program through minor modifications of the HCP, discussed below. Adaptive management provides a greater measure of certainty that HCP goals for covered species are achieved by: 1) gauging the effectiveness of existing conservation measures in consultation with the USFWS, 2) proposing alternative or modified conservation measures as the need arises, and 3) addressing changing and unforeseen circumstances (Reclamation 2004).

MINOR MODIFICATIONS

Minor modifications are changes made to conservation measures in the HCP through the adaptive management process. These are formal changes that occur through consultation with the USFWS and are approved by the LCR MSCP Steering Committee. Minor modifications typically arise from a need for the clarification or altered interpretation of a conservation measure based on new information gained through research and monitoring efforts. It can also arise from the need to adjust some particular language in a conservation measure based

unforeseen changes or other limitations. Minor modifications represent small changes that do not substantially change the original intent or outcome of the conservation measure.

Two minor modifications were made to fish augmentation conservation measures in late 2010. The minor modifications were for razorback sucker (Program Decision Document 11-002, attachment 3) and bonytail (Program Decision Document 11-003, attachment 4), and both of these modifications were initiated by a combination of research findings and unforeseen hatchery production constraints. Because of low estimated survival of stocked fish, the minor modifications for both razorback sucker (Conservation Measure RASU 3.1) and bonytail (Conservation Measure BONY 3.3) suspended the initiation of experimental stockings below Palo Verde Dam until additional survival studies could be completed. In addition, hatchery production was hindered for both species due to invasion of quagga mussels in the LCR and the discovery of largemouth bass virus at hatcheries. As a result, the minor modifications also extended the experimental stocking period from 5 to 10 years to compensate for production limitations. The total number of fish to be stocked for both species was unchanged.

Recordkeeping and Data Management

LCR MSCP staff will maintain all raw data, quality assured/quality controlled data, datasheets, bound water proof field notebooks, data input and output process, scans of data sheets, spatial data, metadata, analyzed data outputs, and databases for the fish augmentation program. Currently, Reclamation (under the LCR MSCP) provides funds to maintain a database for native Colorado River fishes stocked downstream from the Grand Canyon. This database includes fish from all state and Federal facilities and programs, and the data are available to these agencies and institutions. Reclamation (under the LCR MSCP) continues to support both the Lake Mohave repatriation program and augmentation stockings required by past ESA consultations. LCR MSCP staff will develop an in-house data management system for all LCR MSCP data. Until this in-house system is in full operation, LCR MSCP staff will continue its use and support of the current database for the fish augmentation program.

Data collection using bound, waterproof notebooks (and then transferred to an electronic file) will continue until new standardized electronic field data dictionaries, also known as mobilized electronic field forms (MEFFs), are developed, tested, and implemented. MEFFs are currently being developed to organize and standardize all data collected for the LCR MSCP, other partners, and stakeholders.

CONDITIONS AND CRITERIA UNDER WHICH FISH AUGMENTATION MAY CEASE

Stocking of razorback sucker and bonytail may cease in one or more reaches if, through monitoring and research, it is determined (for the reach) that:

1. Stocking efforts have resulted in adequate numbers of adults to provide genetic refuge or to evaluate management activities related to creating a self-sustaining population (i.e., species conservation/recovery goals have been achieved).

2. Conservation actions other than stocking would be more effective in contributing to the recovery of the species.

3. There are factors within the reach that are not conducive to the survival of stocked fish to become adults or to be managed toward a self-sustaining population.

4. Biological or other factors warrant cessation of stocking.

At this time, Reclamation anticipates that information to invoke one or more of the above criteria is unlikely to be available before the year 2027 due to the following reasons:

- The adaptive management program requires a 10-year period of increased razorback sucker and bonytail stocking to satisfy experimental stocking regimes. This can occur once current rearing capacity is ramped up to provide 12,000 additional razorback sucker (6,000 for Reach 3 and 6,000 for Reaches 4/5) and 4,000 additional bonytail per year for Reaches 4/5.

- This level of production is not expected to be available until the year 2017.

- Once these accelerated stockings begin, the adaptive management strategy allows for a 10-year period of focused monitoring and research on these fishes. The observations from the monitoring and research will be analyzed to determine the effectiveness of the fish augmentation program and the need for cessation, continuation, or alteration of razorback sucker and bonytail stocking.

Alternative Measures to Minimize and Fully Mitigate for Authorized Take in the Event Fish Augmentation Measures Cease

In the event that fish augmentation ceases for one or both species in one or more LCR reach, Reclamation will consult with the USFWS and the State fishery resource agencies (AGFD, CDFW, and NDOW) to determine alternative mitigation measures to be implemented that would fully mitigate for authorized take of these fish species. At a minimum, Reclamation will consider the following alternative actions:

- Stock fewer, but larger fish to substantially increase survival
- Establish fish in additional isolated backwaters and off-channel refugia that could be maintained free of nonnative fishes
- Fund additional research to identify reasons for augmentation failures and develop and implement remedial measures

Status of Fish Augmentation Program and Future Augmentation Strategies

Through fiscal year (FY) 2014, a total of 141,967 razorback and 66,708 bonytail have been stocked under the LCR MSCP in Reaches 3–5 of the LCR. The LCR MSCP 50-year timeline indicates that, with 40 years remaining, the program is approximately 18% complete. When the total number of stocked fishes is compared to this timeline, razorback sucker augmentation is 22% complete, and bonytail augmentation is 11% complete. Overall, the fish augmentation program is tracking properly to meet the commitments in the HCP.

The current status of the fish augmentation program with respect to the goals detailed in the HCP is presented in the summary tables below (tables 1 and 2) for razorback sucker and bonytail. A yearly overview and summary of the fish augmentation program is provided in the annual work plan. These accomplishments are further detailed below by LCR MSCP river reach and a description of how information from research, monitoring, and experience through implementation has informed and influenced fish augmentation implementation strategies.

Table 1.—Razorback sucker LCR MSCP Habitat Conservation Plan stocking accomplishment by type and reach through FY14

Reach	Augmentation type	RASU			% complete
		HCP goal	Current status	Number remaining	
1	ISC/SIA (Type III)	N/A	N/A	N/A	N/A
2	Population augmentation (Type I)	N/A: Maintenance of genetic broodstock	97,733	N/A	N/A
3	Population augmentation (Type I)	270,000	66,670	203,330	25
3	Experimental augmentation (Type II)	60,000	0	60,000	0
4/5	Population augmentation (Type I)	270,000	75,297	194,703	28
4/5	Experimental augmentation (Type II)	60,000	0	60,000	0
	Total	**660,000**	**141,967**	**518,033**	**22**

Table 2.—Bonytail LCR MSCP Habitat Conservation Plan stocking accomplishment by type and reach through FY14

Reach	Augmentation type	BONY			% complete
		HCP goal	Current status	Number remaining	
1	ISC/SIA (Type III)	N/A	N/A	N/A	N/A
2	Population augmentation (Type I)	200,000	0	200,000	0
3	Population augmentation (Type I)	200,000	46,742	153,258	23
3	Experimental augmentation (Type II)	N/A	N/A	N/A	N/A
4/5	Population augmentation (Type I)	180,000	19,966	160,034	11
4/5	Experimental augmentation (Type II)	40,000	0	40,000	0
	Total	**620,000**	**66,708**	**553,292**	**11**

Reach 1

The Reach 1 (ISC/SIA) commitments have been satisfied. In 2004, elevations in Lake Mead dropped below 1,160 feet in February, March, and April and were identified as a "partial domestic surplus" condition. This circumstance triggered actions under the ISC/SIA Biological Opinion that had been assumed under implementation of the LCR MSCP specific to conservation measure RASU8. The assumption that the ISC/SIA had based these actions on was that razorback sucker spawning would be reduced or eliminated if lake levels fell below 1,160 feet (Reclamation 2004). In accordance with this conservation measure, in 2005, a multi-agency staff participated in the collection of over 4,000 Lake Mead larval razorback sucker for the purpose of rearing and repatriation into the LCR.

In 2002, the spawning population of razorback sucker in Lake Mead was reported to have moved to a lower elevation in the lake and spawned because the spawning location they has used previously was dry (2004; Abate et al. 2002). According to the LCR MSCP Habitat Conservation Plan (Reclamation 2004), "This change indicates that razorback sucker can successfully move their spawning location into progressively lower elevations as the lake recedes. Given this new information, the LCR MSCP and USFWS will evaluate the data developed in conservation measure RASU6 and determine whether larva collection is appropriate and, if so, at what water elevation it should be implemented." Subsequent research has continued to corroborate this ability for razorback sucker to move spawning locations as lake levels recede (Albrecht et al. 2014 (*in prep.*) [D8]). The USFWS and Reclamation have determined that larvae collection for the ISC/SIA is no longer necessary; however, in every year since the program was implemented, LCR MSCP staff have continued to assist in the collection of larvae from Lake Mead as part of routine monitoring, for experimental purposes, and for rearing (Albrecht et al. 2006, 2007, 2008, 2010 [C13], 2013a, 2013b, 2014 [D8]; Kegerries et al. 2009 [C13]; Shattuck et al. 2011 [C13]; NDOW 2007 [B6]; Herndon and Sjöberg 2008 [B6]; Herndon 2008 [B6], 2010 [B6]; Senger 2011 [B6]; Senger and Sjöberg 2012 [B6]; Wright and Senger 2013, 2014 [B6]). The NDOW maintains "Lake Mead origin" razorback sucker adults on station at the LMFH for potential future augmentation into Lake Mead. The ISC/SIA ends in December 2015.

The Lake Mead population of razorback sucker presents a promising opportunity for conservation and potential recovery action for this species as it continues to exhibit the ability to naturally recruit individuals (Albrecht et al. 2014 (*in prep.*) [D8]). This population is a potential candidate to be designated as a recovery population by the USFWS. Conservation efforts for razorback sucker will continue to be supported under the LCR MSCP as allowed under Conservation Measure RASU1, including assisting in the efforts of other conservation and recovery programs to augment existing razorback populations in Lake Mead

(Reclamation 2004). Any augmentation assistance provided under the LCR MSCP toward other conservation or recovery goals will not result in augmentation credit under the LCR MSCP Habitat Conservation Plan.

Reach 2

Razorback

The augmentation goals for Reach 2 are currently being satisfied. Although the Lake Mohave NFWG goal of restoring the adult population of the lake to 50,000 individuals has not been achieved, support toward this goal has continued under the LCR MSCP through the stocking of over 97,000 subadult (over 300 mm) razorback sucker into Lake Mohave through FY14. The population size of razorback sucker in Lake Mohave is considered stable (Wisenall et al. 2015 [D8]). Additionally, with the implementation of the current augmentation strategy, we have been able to maintain adequate levels of genetic diversity within the Lake Mohave broodstock (Dowling et al. 2014 [C31]).

The goal of "restoring 50,000 adults" was based on population estimates for razorback sucker in Lake Mohave from the 1980s to early 1990s (Marsh 1994; Minckley et al. 2003). At the Lake Mohave NFWG meeting in 2015, the rationale for this original goal was discussed. Members of the group indicated that the number "50,000 adults" was thought to be achievable by stocking subadult fish into the lake. The members generally agreed that, in retrospect, this number was probably not achievable (due to observed survival rates of stocked razorback sucker) nor was it necessary to maintain adequate levels of genetic diversity of the Lake Mohave razorback sucker broodstock. Further discussions with both the Lake Mohave NFWG and the USFWS will be necessary to revise the adult population goal that will need to be achieved and maintained for the Lake Mohave broodstock. This number of adult fish will need to provide both adequate population stability and genetic diversity in the broodstock for razorback sucker in the LCR. When this has been decided, a minor modification to the HCP will be implemented to appropriately to reflect the change in conservation measure RASU5.

Regardless of the population size of Lake Mohave, the levels of genetic diversity within the Lake Mohave razorback sucker broodstock are being maintained. The practice of only stocking "Lake Mohave origin" fish into Lake Mohave has likely contributed to this achievement. Population estimates for Lake Mohave razorback sucker substantially increased after 2009. A large part of this was due to the discovery of a subpopulation (much larger than originally assumed before the use of PIT scanning technology) of razorback sucker below Hoover Dam that essentially doubled the population estimate for Lake Mohave (Kesner et al. 2012a [C12]). There are still, however, genetic concerns for this broodstock population. Although currently considered adequate to maintain genetic diversity, research suggests that the current population size of razorback sucker in Lake Mohave may

not be sufficiently resilient to random effects (Dowling et al. 2014 [C31]). Two potential strategies for increasing the population size are: 1) stocking more fish or 2) stocking fish that have higher survival rates. Research results suggest a strong correlation between larger fish and survival rates (Kesner et al. 2012a [C12], 2012b [D8]). The desire to increase the population size of the razorback broodstock in Lake Mohave by stocking large fish is not new. In 2006, the Lake Mohave NFWG requested that razorback sucker repatriated into Lake Mohave be 500 mm TL in an attempt to boost the adult population. The augmentation strategy was changed accordingly for Lake Mohave; however, raising fish to 500 mm TL in a raceway-type hatchery setting proved to be problematic. The space and time it took to raise fish to this length at the Willow Beach NFH resulted in very few fish produced from the hatchery for two consecutive years: 601 razorback sucker in 2007 and 108 in 2008. Concerns arose regarding the "balancing act" between the size of the fish and the total number of fish being repatriated per year. In 2010, the augmentation strategy for Reach 2 was modified again; this time rearing strategies targeted repatriating as many fish over 300 mm TL as possible. Information from hatchery staff indicated that at approximately 400 mm, the growth rate of razorback sucker, in terms of length, slows markedly. Provisions were also made under the LCR MSCP to annually stock approximately 1,000 fish greater than 400 mm in Lake Mohave in addition to the production of subadult fish greater than 300 mm.

Since 2012, the annual number of razorback stocked into Lake Mohave has exceeded 12,000 fish. The population appears to be stable, but population growth has not increased substantially (Wisenall et al. 2015 [D8]). Data continue to support the strong positive correlation between the total length of fish at stocking and survival. Modeling efforts have suggested that this would also translate into an increased growth rate for the adult population of razorback sucker in Lake Mohave (Kesner et al. 2012a [C12], 2012b [D8]). Beginning in 2015, a new rearing strategy is being employed at the Willow Beach NFH for razorback sucker augmentation in Lake Mohave. The approach is somewhat conservative but also has incorporated the logistic realities of the hatchery's capacity as well as economic considerations. The plan is to increase the number of fish > 400 mm stocked into Lake Mohave without having an unacceptable decline in total stocking numbers of fish per year. To do this, the hatchery will begin decreasing densities in year-classes of fish over the next 5 years to encourage greater growth, which will result in a slow ramp up of fish to be stocked at > 400 mm. The expectation is to have an entire year-class (8,000–10,000 fish) averaging > 400 mm. Larval collection goals have also been reduced accordingly. Under this scenario, the number of fish stocked per year is expected to remain in the range of 8,000–10,000 razorback sucker. In 5 years, the expectation is to have an entire year-class that averages > 400 mm TL. Razorback sucker > 400 mm also have a higher probability of contributing to the genetic diversity of Lake Mohave within the first year of their repatriation. This strategy is similar to what has been proposed by the Lake Mead Razorback Sucker Work Group for augmentation of the razorback sucker population in Lake Mead.

Bonytail

No creditable bonytail have been stocked into Reach 2 (Lake Mohave) as of FY14. Stockings for bonytail in Reach 2 under the LCR MSCP were not expected to commence until 2016 when the USFWS had completed their own bonytail stocking commitments in Lake Mohave. In 2012, the USFWS satisfied these commitments (attachment 5).

When the LCR MSCP Habitat Conservation Plan was written, a small population of bonytail still existed in Lake Mohave. More recent data suggest that there is no longer a population of bonytail in the lake; there have been no contacts of bonytail since 2005 (Karam and Marsh 2010). This situation no longer supports the original intent of stocking bonytail in Reach 2: to augment an existing population. Instead, LCR MSCP augmentation efforts in Reach 2 would essentially be attempting to re-establish a population of bonytail within Lake Mohave. Because of this change in expected conditions, the augmentation strategy for Reach 2 has also been modified accordingly. Bonytail stocking under the LCR MSCP will resume in Lake Mohave in FY15 as part of a pilot study. The purpose of these pilot releases and intensive tracking is to assess dispersal and movement, habitat use, and survival of stocked bonytail under Work Task C64. A combination of sonic telemetry and remote PIT scanning will be used to track stocked fish. These data will be used in an attempt to discern more appropriate stocking locations for increased survival and to assess the potential augmentation value for this species in this reach. Because of low re-contact rates for this species and challenges in tracking bonytail in these large reservoir environments, it will likely require a number of years of stocking and subsequent intensive monitoring to provide useful data to guide adaptive management decisions. We therefore intend to attempt to fulfill a portion of the stocking requirements for this reach as part of these research/monitoring efforts. Should data suggest that there is no conservation benefit in stocking bonytail in this reach, we will pursue appropriate modifications to this conservation measure. This approach has been proposed based on informal discussions with the USFWS.

Reach 3

Razorback

A total of 66,670 subadult razorback sucker (at least 300 mm TL) have been stocked in Reach 3 (see table 1). These stocked fish represent partial fulfillment of the Type I stocking for this reach. Although a number of research investigations, including intensive monitoring for razorback sucker have been conducted above Parker Dam since 2010, stocking numbers have not been consistently large enough (6,000 additional fish per year above Parker Dam for 10 years) to meet the Type II stocking intentions.

Reach 3 currently supports the largest population of razorback sucker in the LCR. Recent data estimates the population at approximately 4,500 individuals (Ehlo

et al. 2015 [C33]). This represents 6% of the subadult fish stocked in this reach under the LCR MSCP, through FY14. This ratio of number of fish stocked to population size in Reach 3 is about double of what we have seen in Lake Mohave (3%) over the same time period (Ehlo et al. 2015 [C33]; Wisenall et al. 2015 [D8]). The improved success seen in Reach 3 has been attributed to increased overall habitat diversity, when compared to Reach 2. Reach 3 has long, flowing riverine sections with varied flow rates and available backwater habitats along portions of this reach.

Research has suggested that razorback sucker use multiple habitats within Reach 3; they can range large distances but maintain seasonal fidelity to certain locations – in particular, spawning areas (Wydoski and Lantow 2012 [C45]). Razorback sucker in Reach 3 also can use different habitat types during different life stages; juvenile fish were contacted more commonly in shallows and backwaters, whereas adult fish tended to use more main stem habitats. (Wydoski and Lantow 2013 (*in press*) [C45]). Research on habitat selection, post-stocking distribution, and survival for razorback sucker will continue under Work Task C64. Latent mortality studies and, in particular, post-stocking mortality attributed to piscivorous bird predation, will also be evaluated under Work Task C65 in Reach 3.

Experimental stocking treatments are ongoing in Reach 3. These include targeting specific locations within Reach 3 based on contact data and using smaller batch sizes for stocking groups ([C45], [C64] and [D8]). When hatchery production permits, experimental stocking (Type II) will commence in Reach 3; these additional 6,000 razorback sucker per year for 10 years is expected to increase re-contact rates. These additional data will allow for more robust analysis of pre-and post-stocking treatments in this reach and will help to evaluate their effectiveness in increasing survival. Pre-stocking treatments, including flow-conditioned and predator-conditioned fish, may be initiated before experimental stocking regimes commence; however the majority of these experimental treatments will be carried out during these experimental stocking periods in Reach 3.

Although flannelmouth sucker are not stocked as part of the LCR MSCP augmentation requirements, a number of research work tasks have focused on this native fish species in Reach 3. Research conducted under Conservation Measure FLSU2 in Reach 3 on flannelmouth sucker has been focused on habitat use and behavior to identify habitat features that may be important when creating connected backwaters for these native fish. Flannelmouth sucker appear to be self-sustaining; they maintain a population in Reach 3 without supplemental augmentation. Successful recruitment of razorback sucker in Reach 3, however, has not been documented. Possible reasons for this include unique biology, life history and behavior, and habitat use differences between the two species (Best and Lantow 2012 [C15]). Part of the research on flannelmouth sucker under Work Task C53 (Conservation Measure FLSU3) will focus on comparing

behavior and habitat use between flannelmouth and razorback sucker in an attempt to find similarities that may be exploited to benefit razorback conservation and improve augmentation success for razorback sucker in this reach.

It is important for managers implementing the fish augmentation program to consider the entire LCR when formulating conservation-minded stocking strategies to meet the intent of the HCP. Because of the larger population of razorback sucker and additional habitat advantages, Reach 3 may have increased conservation potential for the fish augmentation program. In an effort to exploit these opportunities, some changes are being implemented to the augmentation strategy for this reach. Stocking rates will remain consistent to continue to meet the augmentation goals of the HCP; however, when possible, additional Lake Mohave broodstock origin fish are being directed to Reach 3. The majority of razorback sucker stocked into Reach 3 come from Bubbling Ponds. Beginning in 2007, the invasion of quagga mussels changed the origin of fish reared at Bubbling Ponds from Lake Mohave broodstock to the SNARRC broodstock. Although the SNARRC broodstock razorback sucker are intensively managed to maintain sufficient levels of genetic diversity, the Lake Mohave broodstock is considered to be superior in terms of genetic diversity and allelic richness (Dowling et al. 1996, 2012). Because there is still uncertainty surrounding the future of the Lake Mohave population of razorback sucker, it is prudent to attempt to build additional refugia for razorback sucker genetics; Reach 3 appears to be an appropriate choice. This process of augmenting the razorback sucker genetics of Reach 3 is more opportunistic (the priority is still to maintain Lake Mohave genetic diversity) and not a formal protocol like the one being developed for Lake Mead razorback sucker. It is, however, expected to move toward improving genetic diversity in this reach and has been supported by the research community. With the changes in the augmentation strategy for Reach 2, specifically to make space at the Willow Beach NFH for rearing larger fish for Lake Mohave, additional Lake Mohave broodstock razorback may be made available for stocking into Reach 3. When possible, future production strategies will also move toward directing a portion of Lake Mohave broodstock fish to Reach 3.

Bonytail

A total of 46,742 bonytail greater than 300 mm have been stocked into Reach 3 of the LCR. This represents over 20% of the augmentation commitment (200,000 subadult bonytail) that is required over the 50-year term of the LCR MSCP. With the program lifespan at approximately 18% complete, bonytail stocking rates in Reach 3 are slightly ahead of schedule.

Reach 3 also represents the portion of the LCR that may hold the most promise for bonytail conservation. Habitat diversity, more specifically, appropriate available cover, has been suggested as an important factor impacting the survival

of these fish. Bonytail appear to select areas with higher turbidity or bulrush (Humphrey et al. 2014 [C39]; Karam et al. 2013 [C39]). The inflow area of the Bill Williams River has been identified as an area where bonytail have persisted for over 1 year after release. Recent studies have indicated higher survival rates in some areas of Topock Gorge (Humphrey et al. 2014 [C39]). Nevertheless, re-contact rates of bonytail in this reach are extremely low. In general, fish are not re-contacted beyond a year after stocking (Humphrey et al. 2014 [C39]). Stocking efforts over the next 5 years are intended to continue to meet augmentation goals in this reach, while concurrent research will guide stocking efforts to locations where fish have the greatest chance of survival and where adequate habitat conditions are available.

Research on habitat selection, post-stocking distribution and survival will continue under work task C64. Additional stocking locations in Topock Gorge as well as in Park Moabi are being are being assessed. Latent mortality studies, and in particular, post-stocking mortality attributed to piscivorous bird predation will be evaluated under C65 in Reach 3.

Reaches 4/5

Stocking rates for Reaches 4/5 mirror the overall program augmentation accomplishment rate, with razorback numbers slightly accelerated (28%) and bonytail numbers slightly behind (11%) (see tables 1 and 2). Experimental (Type II) stocking in these reaches, however, has yet to be implemented. Challenges in fish production and poor initial estimates of survival have moved the research and monitoring focus away from these reaches until recently. Surveys conducted over the past 2 years have confirmed a small population of razorback sucker in the A-10 backwater in Reach 4, below Palo Verde Dam. Some of the individuals were stocked over 9 years ago. These areas were previously thought to have too high of predation rates on native fishes for any potential persistence of stocked fish (Schooley et al. 2008 [C8]).

Consequently, additional surveys, research, and pilot stocking and tracking are being conducted in Reaches 4/5 under Work Task C64. Monitoring protocols and sampling networks are being established in preparation for the implementation of experimental stocking (Type II) regimes for these reaches. The general approach for both species will be to identify stocking locations where these fishes have the highest re-contact probabilities. This will be necessary not only to draw meaningful inference from subsequent experimental stocking or pre-stocking conditioning treatments, but it may also help identify areas that show continued persistence because of higher local survival, habitat selection, or a combination of these factors.

When hatchery production allows, presumably by FY17, we expect to commence these experimental stockings in Reaches 4/5. These additional 6,000 razorback sucker per year and 4,000 bonytail per year for 10 years is expected to increase re-contact rates. These additional data will allow for more robust analysis of pre-and post-stocking treatments in this reach and will help to evaluate their effectiveness in increasing survival. Pre-stocking treatments, including flow-conditioned and/or predator-conditioned fish, are expected to begin in FY18.

Razorback

A total of 75,297 razorback sucker of at least 305 mm TL have been stocked within Reaches 4/5 of the LCR through FY14. These stocked fish represent partial fulfillment of the Type I stocking for these reaches. Although a number of research investigations for razorback sucker have been conducted below Parker Dam, these efforts have not been continuous, and stocking numbers have not been consistently large enough (6,000 additional fish per year below Parker Dam for 10 years) to meet the Type II stocking intentions.

Bonytail

A total of 19,966 bonytail of at least 305 mm TL have been stocked within Reaches 4/5 of the LCR through FY14. These stocked fish represent partial fulfillment of the Type I stocking for these reaches. Although a number of research investigations for bonytail have been conducted below Parker Dam, these research efforts have not been continuous, and stocking numbers have not been consistently large enough (4,000 fish per year below Parker Dam for 10 years) to meet the Type II stocking intentions.

Proposed Stocking Allocations

The augmentation strategies described above can only be accomplished by ensuring the proper level of production at hatcheries relied upon for the LCR MSCP. Table 3 illustrates the estimated annual production at each hatchery/facility for each species and the contribution of these fishes to augmentation goals by LCR MSCP reach. These numbers, in general, represent conservative estimates of projected hatchery production; however, there can be variation in the numbers of fish produced from year to year. The table has been developed under the scenario that annual requirements are being fulfilled at the maximum augmentation rate for each reach. Current productions rates have been sufficient to stay on track with the goals of the fish augmentation program; however, in order to meet the demands of additional experimental stocking in Reach 3, and bonytail commitments in Reach 2 starting in FY16, production rates will need to be increased, and/or fish by reach may need to be reallocated.

Table 3.—Current hatchery native fish production to meet goals of the LCR MSCP Habitat Conservation Plan at maximum augmentation rates and stocking allocation by reach in Reaches 2, 3, and 4/5

Stocking type	Reach 2 RASU/year	Reach 3 RASU/year	Reaches 4/5 RASU/year		Reach 2 BONY/year	Reach 3 BONY/year	Reaches 4/5 BONY/year
Population augmentation (Type I)	N/A	6,000	6,000		5,000	4,000	4,000
Experimental augmentation (Type II)	N/A	6,000	6,000		N/A	N/A	4,000
Total	N/A	**12,000**	**12,000**		**5,000**	**4,000**	**8,000**
Hatchery contribution							
Willow Beach NFH	8,000	0	0		0	0	0
Achii Hanyo	0	500	0		0	4,000	0
SNARRC	0	0	0		0	0	8,000
LMFH	500	2,000	0		0	0	0
Bubbling Ponds	0	4,000	12,000		0	0	0
Total	**8,500**	**6,500**	**12,000**		**0**	**4,000**	**8,000**

Agreements with the SNARRC are already in place to increase production of bonytail to 13,000, 305 mm fish within the next 5 years. If hatchery production can meet these projections, then there will be adequate numbers of fish to satisfy the bonytail augmentation goals for all reaches. Nevertheless, because of the variability in yearly growth rates and production numbers, especially for bonytail, LCR MSCP staff will seek additional production at hatcheries already in the program as well as looking for rearing space in other hatcheries in the Southwest. Additional rearing space will also be sought for razorback sucker to allow for the implementation of experimental stocking regimes in Reach 3.

Future hatchery expansion and production increases may be possible at the LMFH and Bubbling Ponds. Discussions have been initiated exploring the feasibility of these opportunities. Table 4 provides a timeline and allocation of native fish stocking based on current and projected production capacities. The allocation table is based on the assumption that additional production will be achieved to compensate for the increased bonytail stocking goals in Reach 2. This is depicted in table 4 as a slower initial stocking rate for Reach 2; this allows for both the development of hatchery production and time for pilot stocking studies to evaluate the effectiveness and conservation value of stocking bonytail into Reach 2. The table also illustrates the strategy of staggered allocation of stocked fish to provide for the additional experimental stocking (Type II) of both razorback sucker and bonytail in Reaches 3 and 4/5. This directed allocation includes concurrent stocking of both razorback sucker and bonytail in

Table 4.—Timeline and allocation of fish stocking to meet LCR MSCP Habitat Conservation Plan goals for razorback and bonytail by reach

Reach	Augmentation type	Years	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2055
2	BONY Population augmentation 5,000 per year		1,000	1,000	2,000	2,000	2,000	5,000	5,000	5,000	5,000	5,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	5,000
3	RASU Population augmentation (Type I) 6,000 per year		6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
3	RASU Experimental augmentation (Type II) 6,000 per year		0	0	0	0	0	0	0	0	0	0	0	0	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	0
3	BONY Population augmentation (Type I) 4,000 per year		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
3	BONY Experimental augmentation (Type II) N/A																								
4/5	RASU Population augmentation (Type I) 6,000 per year		6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
4/5	RASU Experimental augmentation (Type II) 6,000 per year		0	0	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	0	0	0	0	0	0	0	0	0	0	0
4/5	BONY Population augmentation (Type I) 4,000 per year		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
4/5	BONY Experimental augmentation (Type II) 4,000 per year		0	0	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	0	0	0	0	0	0	0	0	0	0	0

Reaches 4/5 at the maximum stocking rate (including both Type I and Type II stocking) from 2017 through 2026. By employing this strategy, we can increase efficiency by conducting both stocking and intensive tracking/monitoring and research on both species with little additional effort and share resources when sampling is conducted. When the 10-year experimental stocking has been completed in Reaches 4/5, the production and stocking of those fish will be redirected; the 6,000 razorback sucker will be stocked into Reach 3 to meet experimental augmentation goals for that reach, and the 4,000 bonytail will be stocked toward the goals in Reach 2 if results from pilot stockings in Reach 2 suggest that this action has conservation value for bonytail. If additional production of native fishes can be secured, these stocking projections for Reach 3 (razorback sucker experimental stocking) and Reach 2 (bonytail stocking – if warranted) may be accelerated.

The current production targets so far have been secured on an incremental basis through financial agreements with hatchery facilities. We intend to further secure these commitments through long-term agreements with the State and Federal agencies that operate these facilities. Nevertheless, we will continue to be proactive in identifying alternate locations and ways to diversify and improve native fish production to safeguard against the new challenges that are likely to face the fish augmentation program in the future.

Augmentation Framework by Reach for 2015–2020

The framework below summarizes the augmentation actions by reach for the years 2015–2020. These actions include projected stocking numbers, stocking type, (by species), stocking strategies, and proposed research.

Reach 1

Razorback: Continue to assist with conservation efforts for razorback sucker in Lake Mead, including coordination with the Lake Mead Razorback Sucker Work Group, continuation of ongoing and future research and monitoring of the Lake Mead razorback sucker population, and potential assistance in small-scale augmentation efforts for razorback sucker.

Reach 2

Razorback: Continue stocking razorback sucker in Lake Mohave (reared from Lake Mohave origin broodstock) to maintain genetic diversity of the broodstock.

Initiate and monitor a new rearing strategy at the Willow Beach NFH intended to produce larger (400 mm average TL) razorback sucker with the goal of increasing the adult population size in Lake Mohave.

When possible, rear and stock larger fish (approximately 500 mm) in Lake Mohave using other grow-out ponds and rearing facilities in an attempt to further increase the adult population size.

Bonytail: Initiate pilot stocking of bonytail in Lake Mohave, with the goal of suggesting relative conservation value for bonytail and either identifying the best stocking approaches for this reach or providing data to support adaptive management changes to Conservation Measure BONY 3 for stocking bonytail in Reach 2.

Reach 3

Razorback: Continue long-term augmentation (Type I) of 6,000 razorback sucker per year (300 mm or greater in length).

When possible, stock Lake Mohave origin razorback sucker in Reach 3 to improve the genetic diversity of the repatriated population.

Continue monitoring and research of stocked razorback sucker under Work Task C64 (post-stocking movements, distribution, habitat use, and survival).

Initiate latent mortality research investigations for razorback sucker and bonytail under Work Task C65.

Seek additional rearing capacity to produce additional 6,000 razorback sucker per year for Reach 3 experimental stocking regimes (Type II).

If additional production can be secured, implement experimental stocking and prepare for paired releases of flow- and predator-conditioned fish.

Bonytail: Continue long-term augmentation (Type I) of 4,000 bonytail per year (300 mm or greater in length).

Continue monitoring and research of stocked bonytail under Work Task C64 (post-stocking movements, distribution, habitat use, and survival).

Initiate latent mortality research investigations for razorback sucker and bonytail under Work Task C65.

Reaches 4/5

Razorback: Continue long-term augmentation (Type I) of 6,000 razorback sucker per year (305 mm or greater in length).

Continue monitoring and research of stocked razorback sucker under Work Task C64 (post-stocking movements, distribution, habitat use, and survival).

Initiate experimental augmentation regimes (Type II) for razorback sucker of an additional 6,000 fish per year (300 mm or greater in length); expected to begin in 2017 (if hatchery production allows).

Assuming adequate hatchery production is available for experimental stocking, prepare for paired releases of flow- and predator-conditioned fish.

Implement other research investigations as appropriate to maximize the benefit of experimental stocking regimes, including day/night stocking, varying stocking batch size, etc. (Work Task C61) and latent mortality research investigations for razorback and bonytail under Work Task C65.

Bonytail: Continue long-term augmentation (Type I) of 4,000 bonytail per year (305 mm or greater in length).

Continue monitoring and research of stocked bonytail under Work Task C64 (post-stocking movements, distribution, habitat use, and survival).

Initiate experimental augmentation regimes (Type II) for bonytail of an additional 4,000 fish per year (300 mm or greater in length); expected to begin in 2017 (if hatchery production allows).

Assuming adequate hatchery production is available for experimental stocking, prepare for paired releases of flow- and predator-conditioned fish.

Implement other research investigations as appropriate to maximize the benefit of experimental stocking regimes, including day/night stocking, varying stocking batch size, etc. (Work Task C61) and latent mortality research investigations for razorback sucker and bonytail under Work Task C65.

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ATTACHMENT 1

Stocking Locations by Reach

Reach 2	
Lake Mohave locations	**Backwaters**
Antelope Cove	Yuma
Below Liberty Cove	Arizona Juvenile
Carp Cove	South Sidewinder
Cottonwood Cove	Davis
Fortune Cove	North Nine Mile
Liberty Cove	Willow
Mile Marker 51	Nevada Egg
Owl Point Cove	Dandy
Princess Cove	Nevada Larvae
Red Tail Cove	North Chemehuevi
Ringbolt Cove	
River Mile 28-16	
River Mile 49-45	
River Mile 53-48	
Roadrunner Cove	
Sheep Trail Cove	
Six Mile Cove	
Valhalla Cove	
Willow Beach Marina	
Willow Beach National Fish Hatchery	
Wrong Cove	
Reach 3	
Beal Lake	Golden Shores
Beal Slough	Laughlin Lagoon
Big Bend State Recreation Area	Needles Dredge Yard
Bill Williams National Wildlife Refuge (above bridge)	Office Cove
Bill Williams River National Wildlife Refuge	Park Moabi
Bill Williams National Wildlife Refuge Delta	Standard Wash Havasu
Catfish Paradise, Topock Marsh	Windsor Beach State Park
Cattail Cove	

Lake Mohave locations	Backwaters
Reach 4	
A-7	
A-10	Emerald Canyon Golf Course
A-10 Lower	La Paz County Park
A-10 Upper	McIntyre Campground backwater
Buckskin Mountain State Park	Palo Verde Oxbow Lake
Cibola High Levee Pond	River Island State Park
Reach 5	
Imperial National Wildlife Refuge	

ATTACHMENT 2

Juvenile and Subadult Razorback Suckers Repatriated into Lake Mohave Prior to the Implementation of the Lower Colorado River Multi-Species Conservation Program

Year	Lakeside ponds	Boulder City	Fish hatcheries	Yearly total	Cumulative total
1992	150			150	150
1993	542			542	692
1994	2,310			2,310	3002
1995	1,645			1,645	4647
1996	1,649	626		2,275	6,922
1997	3,303	2,504	1,615	7,422	14,344
1998	2,100	3,982	1,574	7,656	22,000
1999	3,591	3,906	8,533	16,030	38,030
2000	1,744	1,726	3,740	7,210	45,240
2001	2,705	2,343	6,348	11,396	56,636
2002	1,635	1,018	7,820	10,473	67,109
2003	1,718	266	14,859	16,483	83,592
2004	1,963		15,303	17,266	100,858
2005	1,694		10,509	12,203	113,061
Total	**26,749**	**16,371**	**70,301**	**–**	**113,061**

ATTACHMENT 3

Change to Conservation Measure for the Razorback Sucker Lower Colorado River Multi-Species Conservation Program, Program Decision Document 11-002

Steering Committee Motion

The Steering Committee approves Reclamation's recommended changes to conservation measure RASU3 to:

RASU3 –Razorback sucker augmentation program. The LCR MSCP will provide a level of funding to support implementation of a stocking/ augmentation program for the razorback sucker providing for the stocking of up to 660,000 subadult razorback suckers (at least 300 mm in length) into the designated critical habitat for the species in Reaches 3, and in Reaches 4 and 5 of the LCR. The figure of 660,000 fish is not a target number for the LCR but represents an assumption (see RASU1) used to define the extent of funding that would be available, with the understanding that the adaptive management process (see 5.12.2.2) would guide the actual stocking program. The elements of the augmentation program divide the conservation efforts into the three reaches with numbers for fish per year per reach:

3.1 Implement an experimental augmentation, at a site(s) to be selected in cooperation with USFWS and state game and fish agencies, of 12,000 subadult razorback suckers each year for ten years (120,000 total augmentation,) and conduct intensive follow-up monitoring. When razorback sucker production capacity allows, razorback sucker production will be ramped up, with a target production of 120,000 300-mm subadult fish over a 10-year period (i.e., about 12,000 subadult fish per year). Of the 120,000 subadult fish, 6,000 300-mm fish will be stocked annually above Parker Dam and 6,000 300-mm fish below Parker Dam to facilitate maintenance of current juvenile and adult abundance. The augmentation program will also support maintenance and protection of the genetic diversity of existing populations in Lake Mohave (conservation measure RASU 4).

Current Conservation Measure

5.7.6.2 Conservation Measures (LCR MSCP 2004)

RASU3 –Razorback sucker augmentation program. The LCR MSCP will provide a level of funding to support implementation of a stocking/ augmentation program for the razorback sucker providing for the stocking of up to 660,000 subadult razorback suckers (at least 300mm in length) into the designated critical habitat for the species in Reaches 3, and in Reaches 4 and 5 of the LCR. The figure of 660,000 fish is not a target number for the LCR but represents an assumption (see RASU1) used to define the extent of funding that would be available, with the understanding that the adaptive management process (see 5.12.2.2) would guide the actual stocking program. The elements of the augmentation program divide the conservation efforts into the three reaches with numbers for fish per year per reach:

3.1 Implement an experimental augmentation, at a site(s) to be selected in cooperation with USFWS and state game and fish agencies, of 24,000 subadult razorback suckers each year for five years (120,000 total augmentation,) and conduct intensive follow-up monitoring. When razorback sucker production capacity allows, razorback sucker production will be ramped up, with a target production of 120,000 300-mm subadult fish over a 5-year period (i.e. about 24,000 subadult fish per year). Of the 120,000 subadult fish, 6,000 300-mm fish will be stocked annually above Parker Dam and 6,000 300-mm fish below Parker Dam to facilitate maintenance of current juvenile and adult abundance. The augmentation program will also support maintenance and protection of the genetic diversity of existing populations in Lake Mohave (conservation measure RASU 4).

Justification

Approximately 2.5 million razorback suckers have been stocked into the LCR between Parker and Imperial Dams since 1983, including 80,000 since 2000. Subsequent monitoring conducted between January 2006 and April 2008 contacted 2281 fish (Schooley et al., 2008). After analysis of these data, a recommendation to suspend stocking of razorback suckers within the main stem LCR below Palo Verde Diversion Dam has been proposed to U.S. Fish and Wildlife Service and California Department of Fish and Game. Studies will be conducted to further define past stocking success and to evaluate limited stocking within several backwaters that are occasionally connected to the main stem during times of high flow.

Production capabilities have been limited due to several issues not anticipated during LCR MSCP planning, including quagga mussel infestation of the LCR and the detection of largemouth bass virus at several National Fish Hatcheries. Studies are underway to determine management actions to alleviate these conditions.

Once survival studies have been concluded and production issues have been resolved, the experimental stocking call for in Conservation Measure RASU 3.3 will be initiated. Reclamation fish biologists have recommended that the time period for experimental augmentation be increased from 5 years to 10 years to allow identified research to be completed. Total fish stocked will remain unchanged.

Literature Cited

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ATTACHMENT 4

Change to Conservation Measure for the Bonytail Lower Colorado River Multi-Species Conservation Program, Program Decision Document PDD 11-003

Steering Committee Resolution

The Steering Committee approves Reclamation's recommended changes to conservation measure BONY3 to:

BONY3 – Bonytail augmentation program. The LCR MSCP will provide a level of funding to support implementation of a stocking/augmentation program for the bonytail providing for the stocking of up to 620,000 subadult bonytail (at least 300 mm in length) into the designated critical habitat for the species in Reaches 2-3, and in Reaches 4 and 5 of the LCR. The figure of 620,000 fish is not a target number for the LCR but represents an assumption (see BONY1) used to define the extent of funding that would be available, with the understanding that the adaptive management process (see 5.12.2.2) would guide the actual stocking program. The elements of the augmentation program divide the conservation efforts into the three reaches with numbers for fish per year per reach:

3.3 When technology permits, implement an experimental augmentation of 4,000 subadult fish annually in the Parker-Imperial river reach (Reaches 4 and 5) for ten consecutive years within the 50-year program (40,000 total augmentation) and conduct intensive follow-up monitoring. These fish are additional to the annual augmentation listed in BONY 3.4.

Current Conservation Measure

5.7.4.2 Conservation Measures (LCR MSCP 2004)

BONY3 – Bonytail augmentation program. The LCR MSCP will provide a level of funding to support implementation of a stocking/augmentation program for the bonytail providing for the stocking of up to 620,000 subadult bonytail (at least 300 mm in length) into the designated critical habitat for the species in Reaches 2-3, and in Reaches 4 and 5 of the LCR. The figure of 620,000 fish is not a target number for the LCR but represents an assumption (see BONY1) used to define the extent of funding that would be available, with the understanding that the adaptive management process (see 5.12.2.2) would guide the actual stocking program. The elements of the augmentation program divide the conservation efforts into the three reaches with numbers for fish per year per reach:

3.3 When technology permits, implement an experimental augmentation of 8,000 subadult fish annually in the Parker-Imperial river reach (Reaches 4 and 5) for five consecutive years within the 50-year program (40,000 total augmentation) and conduct intensive follow-up monitoring (HCP, pp. 5-42).

Justification

A total of 6425 bonytail were stocked into the LCR between Parker and Imperial Dams in 2006–2007, 1208 in the Parker Strip and 5217 in the river below Palo Verde Diversion Dam. Subsequent monitoring conducted between January 2006 and April 2008 contacted 177 fish (Schooley et al., 2008). After analysis of these data, a recommendation to suspend stocking of bonytail within the main stem LCR below Palo Verde Diversion Dam has been proposed to US Fish and Wildlife Service and California Department of Fish and Game. Studies will be conducted to further define past stocking success and to evaluate limited stocking within several backwaters that are occasionally connected to the main stem during times of high flow.

Production capabilities have been limited due to several issues not anticipated during LCR MSCP planning, including quagga mussel infestation of the LCR and the detection of largemouth bass virus at several National Fish Hatcheries. Studies are underway to determine management actions to alleviate these conditions.

Once survival studies have been concluded and production issues have been resolved, the experimental stocking call for in Conservation Measure BONY 3.3 will be initiated. Reclamation fish biologists have recommended that the time period for experimental augmentation be increased from 5 years to 10 years to allow identified research to be completed. Total fish stocked will remain unchanged.

Literature Cited

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Schooley, J.D., B.R. Kesner, J.R. Campbell, J.M. Barkstedt, and P.C. Marsh. 2008. Survival of Razorback Sucker in the Lower Colorado River, Final Report, January 2006 – April 2008. Arizona State University. 55 p.

ATTACHMENT 5

USFWS Memorandum: Conclusion of 1994 Intra-Service Biological Opinion for Stocking of Rainbow Trout and Channel Catfish in the Lower Colorado River

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

In reply refer to:

AESO/SE
22410-1994-F-0244

April 27, 2012

Memorandum

To: Fisheries Supervisor, Fisheries and Aquatic Resources Conservation, Fish and Wildlife Service, Albuquerque (Attn: Jennifer Fowler Propst)

From: Field Supervisor, Arizona Ecological Services Office, Phoenix, Arizona

Subject: Fish and Wildlife Service Stocking of Rainbow Trout and Channel Catfish in the Lower Colorado River: Conclusion of Project Covered in July 1, 1994 Intra-Service Biological Opinion.

Thank you for your correspondence of April 17, received on April 19, 2012. This memorandum documents our review of your analysis of the status of the subject action and conservation measures included in the July 1, 1994 biological opinion (BO) in Mohave, La Paz, and Yuma counties, Arizona, Clark County, Nevada, and Riverside, San Bernardino, and Imperial counties, California, in compliance with section 7 of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 et seq.). The listed species of concern in this consultation are the endangered bonytail (*Gila elegans*), razorback sucker (*Xyrauchen texanus*), and their designated critical habitat on the lower Colorado River. The proposed action in the BO was for yearly stocking of rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) into certain areas along the lower Colorado River, and the action did not have a termination date included in the BO. As part of our response to your review, you have requested that we consider this consultation to be terminated with the understanding that a new request for consultation based on a revised proposed action and conservation measures will be forthcoming from your office.

Background

The analysis in the 1994 BO was based on the proposed action to stock 560,500 catchable sized rainbow trout into Lake Mohave, below Davis Dam, and six locations below Lake Havasu annually. Channel catfish would be stocked into one site on the Fort Yuma Indian Reservation where effects to the listed fish species were not likely to occur. To address the potential adverse effects to bonytail and razorback sucker from rainbow trout stockings, the proposed action included the following terms and conditions for bonytail and razorback suckers in Lake Mohave under the Incidental Take Statement:

1. Census razorback sucker population in Lake Mohave annually.
2. Attempt to locate bonytail chub spawning areas in Lake Mohave.
3. Conduct surveys prior to the stocking of rainbow trout in areas 1-5 where razorback suckers are known to spawn. Period extends from November through April when larvae may be present. Trout stocking will not occur if razorback sucker larvae are found.
4. Provide 10,000 advanced razorback sucker fingerlings (300 millimeter) annually for Lake Mohave (1995-1999).
5. Provide 25,000 advanced bonytail chub fingerlings (250-300 millimeter) annually for Lake Mohave (1996-1999).

In 1995-2011, a total of 72,518 bonytail chub (73 percent of the requirement) and 101,445 razorback sucker (203 percent of the requirement) advanced fingerlings were stocked into Lake Mohave by the Fish and Wildlife Service (FWS). Over that same period, the FWS stocked only 28 percent of the total number of rainbow trout allowed for under the proposed action.

Since 1994, the FWS and cooperators in conservation of bonytail and razorback suckers have learned a great deal about the success and failure of current stocking programs into Lake Mohave for these species. Under first the Native Fish Work Group (NFWG) and then the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), stocking and subsequent monitoring of stocked native fish has indicated very low survival rates for bonytail such that the species is very rarely found in the lake. For razorback suckers, stocking programs have been successful in retaining the historical genetic variance found in the population even while the size of the population remains small.

Reinitiation criteria

Current rainbow trout stocking from Willow Beach National Fish Hatchery into Lake Mohave and the Colorado River below Davis Dam is reduced in scope and follows both a different intensity and protocol than considered in the 1994 BO. The consideration of adverse effects to bonytail and razorback sucker in the 1994 BO was based on a much larger number of fish stocked over a greater area and a longer season. As there has been a significant change in the proposed action, reinitiation of consultation is appropriate to consider the effects of the change in action. Although the number of bonytail stocked into Lake Mohave has not reached the level required in the 1994 BO, it has exceeded the level appropriate based on the number of rainbow trout stocked since 1995, and the intent of the measure has been met. Further, 16 years of stocking bonytail and razorback sucker into Lake Mohave has not been as successful in restoring these populations so consideration of other conservation actions is appropriate.

Finally, stocking actions for razorback sucker in the Colorado River below Davis Dam has resulted in establishment of a small adult population that has begun to spawn in several locations within the rainbow trout stocking area. This population was not present in 1994 and effects from stocking rainbow trout in this area need to be considered.

Summary

We believe it is appropriate to consider the existing consultation from 1994 to be closed pending completion of a new consultation relevant to the current rainbow trout stocking action. Maintaining the coverage afforded by the 1994 BO until the completion of a new BO enables continuation of rainbow trout stocking in this interim period. We do believe that not continuing to stock bonytail under the conservation measures in the 1994 BO is not a violation of the terms of the BO, as the efficacy of these actions is questionable. We do suggest that Willow Beach National Fish Hatchery continue to work with the LCR MSCP in their stocking razorback suckers into Lake Mohave as that stocking has shown benefit for that population.

We look forward to working with you on a new consultation for rainbow trout stocking. Lesley Fitzpatrick of my staff (602-242-0210 x236) will be our lead for the consultation. If you have any other questions or we can be of additional assistance, please contact her or me (x244).

Steve Spangle

cc: Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ
Project Leader, AFWCO, Pinetop, AZ
Hatchery Manager, Willow Beach NFH, Willow Beach, AZ

W:\Lesley Fitzpatrick\94-F-0224 closure doc\hrb