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In Reply Refer To:
AESO/SE
02EAAZ00-2018-F-0234

May 25, 2018

Memorandum

To: Chief, Wildlife and Sportfish Restoration Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico (Attn: Nicole Jimenez)

From: Field Supervisor

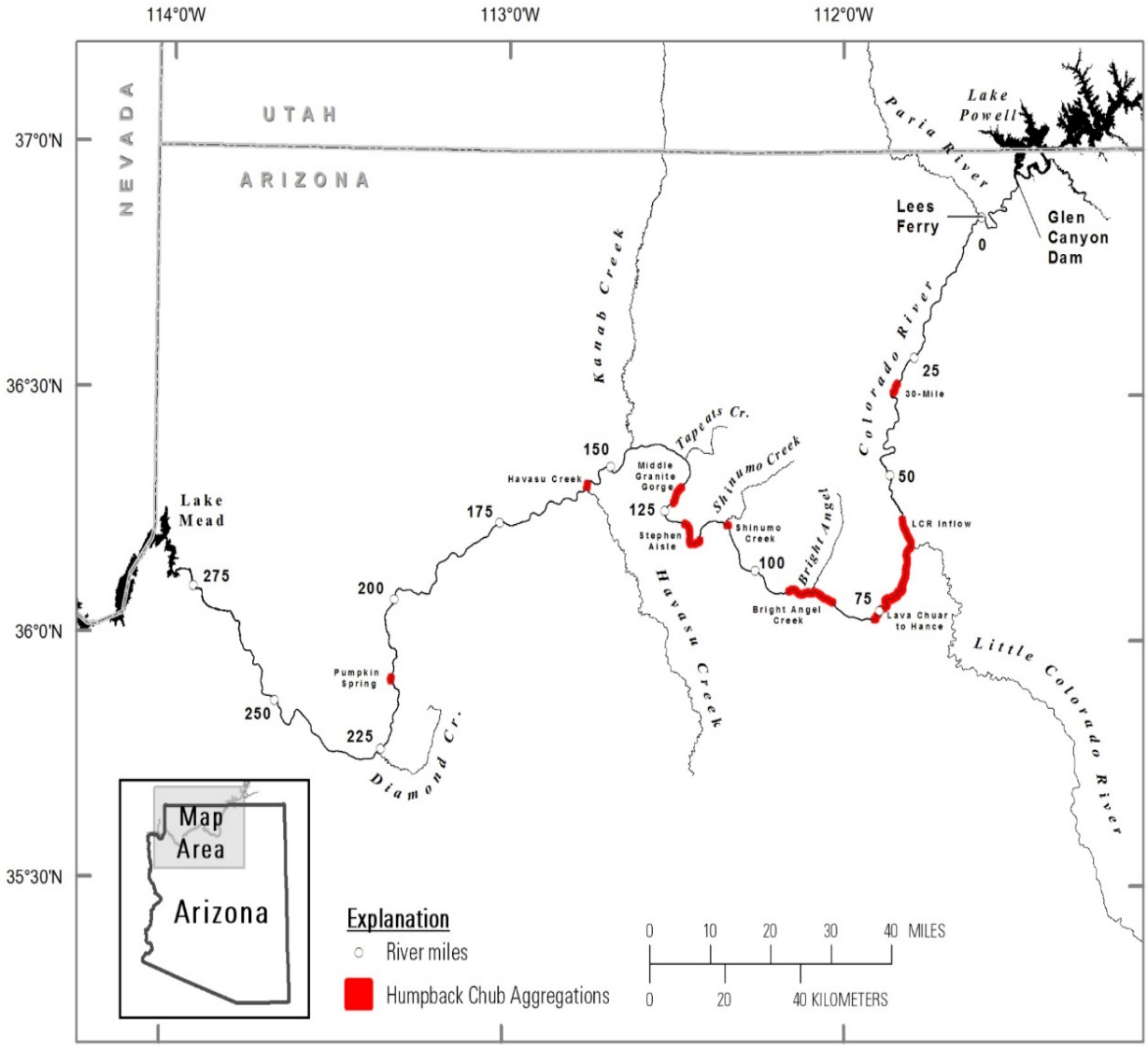
Subject: Biological Opinion for the Intra-Service Section 7 consultation to fund Lees Ferry rainbow trout stocking conducted by the Arizona Game and Fish Department.

Thank you for your request for formal consultation with the Arizona Ecological Services Office (AESO) of the U.S. Fish and Wildlife Service (Service) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (ESA). Your request, dated March 22, 2018, was received in our office on the same day, with a full description of the action being agreed to during a meeting with the Arizona Game and Fish Department (Department) held on February 12, 2018. At issue are impacts that may result from the proposed Federal funding by the Wildlife and Sport Fish Restoration (WSFR) Program of the Service to the Department under a Sport Fish Restoration grant for the rainbow trout (*Oncorhynchus mykiss*) stocking in the Colorado River (River), Coconino County, Arizona. The Department proposes to stock sterile triploid rainbow trout into the 15-mile stretch of the River below Glen Canyon Dam, known as Lees Ferry, during 2018 and 2019 to enhance the recreational rainbow trout fishery. The Department and WSFR program have jointly concluded the proposed action "may affect, and is likely to adversely affect" the endangered humpback chub (*Gila cypha;* chub), and its critical habitat. We agree with the determination and provide the following Biological Opinion (BO). The Action Agencies has concluded the proposed action "may affect, but is not likely to adversely affect" the razorback sucker (*Xyrauchen texanus*) and its critical habitat, and southwestern willow flycatcher (*Empidonax traillis extimus*); nor will it prohibit recovery of the California condor (*Gymnogyps californianus*) and the 10(j) population that exists in the project footprint. We concur with your determinations and provide the rationale for our concurrence in Appendix A of this BO. No conservation measures for the razorback sucker, southwestern willow flycatcher, or California condor were offered by the Action Agencies. In addition, the Action Agencies has made a "no effect" determination for Brady's pincushion cactus (*Pediocactus bradyi*) and Welsh's milkweed (*Asclepias welshii*). Concurrence with, "no effect"

determinations is not required, and thus these species and their critical habitat will not be addressed further in this document.

This BO is based on information provided in the Department's cover letter, Environmental Assessment Checklist (EAC), Section 7 Biological Evaluation Form (BEF), Fisheries Management Plan Colorado River-Less Ferry 2015 (FMP), telephone conversations, meetings between staff, and other sources of information found in the administrative record supporting this BO. Literature cited in this BO is not a complete bibliography of all literature available on the species of concern. The before mentioned documents provided by, and created with, the Department are collectively considered the Biological Assessment (BA) for this proposed action. A complete administrative record of this consultation is on file at this office.

Figure 1. Map of Grand Canyon noting locations of aggregations of Humpback Chub in red.



CONSULTATION HISTORY

2005	Proposed stocking of rainbow trout into Lees Ferry by the Department. Resulting Notice of Intent to Litigate by the Center for Biological Diversity; addressed to DOI partners.
2015-Present	Early coordination talks between Federal, Tribal, and State partners.
April 4, 2017	Department notifies National Park Service (NPS; Glen Canyon and Grand Canyon) via conference call that stocking will occur by May 18, 2017.
April 21	Department sends notification letter to NPS and Service.
May 15	Department sends notification letter Arizona Department of Water Resources (ADWR).
May 15	NPS send a letter of concern to the Department.
May 16	Department postpones stocking.
June 6	Department give presentation notifying the seven Colorado River Basin States.
June 14	Department, NPS, Bureau of Reclamation (Reclamation), and the Service meet in person to coordinate compliance for action.
June 14-18	Multiple calls among partners.
July 9, 26	Department sends draft “Impact analysis” to seven basin states.
July 25	Department provides a webinar to seven basin states, comments received by the Department.
August 30-31	Department presentation to Technical Work Group (TWG) of the Glen Canyon Adaptive Management Program (AMP).
September 11,	Department meetings with ADWR in Governor’s office.
September 19-22	Department conversations with various partners during TWG meeting and brown trout workshop.
September 22	Department receives multiple letters of concern with action.
September 28	Department sends letter to NPS requesting meeting and coordination of Fisheries Management Plans.
December 2017	Department meets with Service Regional Director to request Intra-Service Consultation.
December 8	Department meets with NPS, Bureau of Reclamation (Reclamation), and Service and informs group they will be using federal nexus with the Service and will request intra-service consultation.

December 8	Service receives letter from Department requesting consultation regarding stocking from eggs received from Ennis National Fish Hatchery.
January 16, 2018	Service sends email to Department requesting additional information.
January 24	Service sends email to Department requesting additional information.
January 25	Service provides update to TWG on consultation process.
February 5	Service receives memo from NPS addressing concerns with action.
February 9	Service receives memo from Reclamation addressing concerns with action.
February 12	Service meets with Department to get additional information on full action.
February 13	Service meets with Federal Family Agencies and Tribal Representatives to provide update on action.
February 14-15	Department presents new action to AMWG.
February 16- Present	Service has multiple calls and meetings to coordinate with partners.
March 21	WSFR receives Proposed Job Statement from Department to use WSFR funds for proposed project.
March 22	AESO receives Proposed Job Statement from WSFR and formal consultation is initiated.
April 2018	AESO provides unofficial Draft BO to WSFR and Department.
May 2018	AESO provides official Draft BO to WSFR and Federal Partners.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Supported by funding from WSFR the Department proposes to stock triploid rainbow trout into Lees Ferry to mitigate the reduction in the rainbow trout populations. Since the population of rainbow trout peaked in 2012, after high recruitment occurred in 2011, Arizona's Lees Ferry rainbow trout fishery has experienced a population decline from historic levels (Korman et al. 2012, Korman et al. 2017), abundance declined from a Department estimate of 1.2 million trout to just over 200,000 in 2016. The population of wild rainbow trout in the Lees Ferry reach expresses a boom and bust cycle in population estimation (Korman et al. 2017), consistent with other populations. Due to rainbow trout reproduction in 2016 the rainbow trout fishery has increased to a Department estimate of 375,000 by 2018 (Korman et al. 2017, Rogowski et al. 2017). Stocked rainbow trout will be tagged by fin clip and PIT tagged to facilitate monitoring. This proposed stocking will augment rainbow trout numbers at Lees Ferry during high angler demand to facilitate an increase in angler catch rates, quality of catch and satisfaction with the fishery. Additionally, the proposed action includes monitoring and research to determine how the augmentation of the rainbow trout impacts the success criteria of the sport fishery, and also provides monitoring that will aid in our understanding of the potential dispersal of stocked fish into Grand Canyon and potential impacts to humpback chub and other native species. There is great value in approaching these proposed stocking using controlled experimental methods in that it will inform future management actions while facilitating our desire to proceed with caution regarding impacts to humpback chub and other resources within this geographic area.

The Secretary of the Interior signed a 2017 Executive Order to advance outdoor recreation opportunities, including fishing. The Federal Action is defined as the use of WSFR funding to facilitate the Department's rainbow trout stocking of Lees Ferry, and provides the Federal Nexus that is required by the ESA's Section 7 process of consultation. Other activities outlined, particularly concerning conservation measures regarding the humpback chub, are supportive roles of other Federal partners who maintain our collective coordination in managing the many resources found in the action area.

A full description of the proposed action is in the EAC, BEF, FMP, and meeting notes (collectively the BA) and is summarized below. The Department has provided Objectives as outlined in their FMP for the management of the recreational rainbow trout fishery in these documents. These Objectives have been created and are maintained for the use of the Department management of this fishery only. It is important to note that these Department Objectives are targets that are likely to be accomplished using a variety of tools outside the scope of the proposed action, and are not feasible to be met by stocking alone. As such, we summarize some of the Department's FMP objectives to provide context of the proposed stocking action, but do not support these objectives in totality under this BO. Failure to meet these Objectives themselves is not a trigger to stocking, unless otherwise specified. Matrices for off-ramping and on-ramping the stocking actions are outlined in the conservation measures, outside of the Department's Objectives.

The Department's FMP, EAC, and BEF state the objective guidelines for the recreational rainbow trout fishery in Lees Ferry includes;

1) Angler catch rates of $\geq$ 1 rainbow trout per hour with a condition factor of $\geq$ 1 in the summer months (June – August).
2) Angler catch rates of $\geq$ 10 rainbow trout $\geq$ 14 inches, at least one rainbow trout of $\geq$ 20 inches, in a 10-hour day.
3) Angler use rate of $\geq$20,000 angler days per year as measured by creel surveys.

Triploid Trout Stocking

The following stocking prescription is based on the need to balance enhanced angler catch rates and satisfaction with the density of rainbow trout in the action area. The density of rainbow trout is important because it is one of the contributing factors to movement of trout out of Lees Ferry downstream into areas that are occupied by humpback chub (Yard et al. 2011, Korman et al. 2015). The stocking action is as follows:

The Department will stock triploid rainbow trout into Lees Ferry during 2018 and 2019 to enhance angling matrices outlined in their Lees Ferry FMP.

1) The Department will stock up to 16,000 triploid rainbow trout per year; with no more than 5,000 triploid rainbow trout stocked per month.
2) The Department will stock triploid rainbow trout bi-monthly to monthly into the Lees Ferry walk-in area (Lees Ferry to -2.5 mile) of the Colorado River.
3) Stocking triploid rainbow trout will occur from issuance of this BO to October 15th 2018 and April 1st to October 15th 2019. This coincides with when angling pressures is at its annual average highest.
4) Triploid rainbow trout will be stocked as "catchable" size, defined as a batch average of 250-300 mm total length.
5) Stocking will follow best management practices; which includes multiple measures to prevent the spread of diseases that may impact fish (Department 2001, AFS 2007).

Conservation Measures

The conservation measures are based on current collective actions funded and implemented by agency partners outside of this action and includes National Park Service (NPS), U.S. Geological Survey Grand Canyon Monitoring and Research Center (GCMRC), Bureau of Reclamation (BOR), and the Service. Unless otherwise specified below, the Service and Department are responsible for the funding and implementation of these measures. These measures are designed to avoid and mitigate impacts to the taking of humpback chub. The majority of these conservation measures focus on information gathering and decision trigger points that will facilitate the cessation of stocking to avoid impacts that are outside of what is currently anticipated should they occur, and prior to reinitiation of consultation being triggered. These measures, although not funded by WSFR, will occur with all stocking, and thus become part of the action.

1) The Department will provide annual stocking reports to AESO for dissemination to the Glen Canyon Adaptive Management stakeholders and managers. These reports will analyze the efficacy of this stocking action on recreational fishery performance metrics to reach the purpose and need of this action and impacts to humpback chub from this action. This information will benefit humpback chub in that it will provide additional information to aid management of the species that will enable the action to cease if impacts to humpback chub are greater than anticipated.

2) Due to the hypothesis that outmigration may be a factor driven by density, stocking of triploid rainbow trout will not exceed 5,000 individuals stocked per month. This ensures that densities of stocked rainbow trout will be controlled and will limit outmigration.

3) All stocked triploid rainbow trout will be marked to enable estimates of survival, return to creel, and movement within and from Lees Ferry. Marking of stocked rainbow trout is important to inform managers of any differences in behavior between wild and stocked rainbow trout, especially as it pertains to movement, predation, and density dependent behaviors. This information will help inform where, and to what extent, trout will contact humpback chub and thus possible impacts of take.
    a. Any trout suspected to have out-migrated to or below 30-mile Spring will be collected during Department and Service surveys. River survey effort will be stratified to increase effort just downstream of Lees Ferry and Creel surveys will include additional measures to detect marked fish and analyze return to creel rates.
    b. Trout will be marked using a left pelvic fin clip, so that subsequent capture of fish can be identified as a stocked triploid fish.
    c. The use of Passive Integrated Transponder (PIT) tags and antennas will be made available for this action. Conservation partners have excess PIT tags and have committed to providing these tags to WSFR for this action. Use of PIT tags are preferred because individual fish can be tracked and additional information can be gleaned when compared to a batch mark. Additionally, the use of PIT tags may allow for remote sensing of trout movement and may be the most cost effective means of study. Information concerning movement of stocked rainbow trout is necessary to track the impact of this action on humpback chub. Should more trout move out of the Lees Ferry reach than anticipated, then impacts will be further avoided by the cessation of the stocking action. This monitoring will include;
        i. PIT tagging all individual triploid rainbow trout prior to stocking. Left pelvic fin clip marking will occur along with PIT tagging, to give a visual mark that is easily recognizable.
        ii. Placement of submersible (portable battery-operated) PIT tag sensing antennas below the area of stocking to detect movement of fish outside of the Lees Ferry reach (lowest end of Lees Ferry). Additional submersible antennas are encouraged at the 30 mile reach and the confluence of the Little Colorado River (LCR) and mainstem Colorado River. The Department and Service propose to increase survey effort around 30-mile Spring and place 1 or 2 shore-based (battery operated,

solar charged) PIT tag antennas near 30-mile Spring. Placement of shore-based PIT tag antennas will occur in coordination with NPS including NPS permitting, and approval, and additional funding. The proposed monitoring and PIT tag antenna placement will add to existing surveys, and represents minor adjustments to the current survey effort and funding.

4) The Service and the Department will increase effort to study spawning and recruitment of humpback chub at 30-mile. These efforts will take advantage of other actions in this geographic area when available in order to provide need flexibility in logistical restraints of current river monitoring efforts. Seining data from recent (2017) monitoring at the 30 mile humpback chub aggregation show increasing numbers of young humpback chub in 2016 and 2017. Ninety-nine mostly juvenile humpback chub were sampled in one seine haul at 30 Mile Spring. This effort will include multiple survey methods including the use of a PIT tag antenna and capture by seine. This information will be used during decision points that will inform decision to cease stocking if unanticipated movement or impact to humpback chub occur prior to reinitiation triggers being met as described below. Additionally, recruitment of humpback chub in this area is a relatively new phenomenon that managers know relatively little about. The increased effort to study humpback chub at this location is needed for best management of this aggregation of fish.

5) In the unlikely event that a population level impact is detected in association with this action, the Department will cease stocking immediately. This conservation measure is designed to avoid substantial impacts to the humpback chub population. Consistent with and modified from other actions below Glen Canyon and within BOR's Long-Term Experimental Management Plan (LTEMP), which also provides provision to avoid impacts to humpback chub. In recognition of the LTEMP humpback chub triggers we use added a buffer of impacts which allows avoidance of this action triggering conservation and mitigate for LTEMP. Rainbow trout stocking will cease if any one of three triggers are met:
    a. Stocked triploid rainbow trout numbers increase above 185 individuals at 30-mile and downstream estimated annually. This is based on the high range of predicted movement, with a buffer of rainbow trout out of Lees Ferry and to 30-mile and the LCR reaches (See appendix B).
    b. If the combined point estimate for adult humpback chub (adults defined $\geq$ 200mm) in the Colorado River mainstem LCR aggregation (RM 57-65.9) and the LCR falls below 9,450 as estimated by the currently accepted humpback chub population model (e.g. LTEMP estimate 9,000 with a 5% buffer and addition of 450 fish).

    OR

    c. If recruitment of sub-adults humpback chub (150-199 mm) does not equal or exceed adult mortality such that:
        i. Sub-adult abundance falls below a three- year running average of 1,313 fish in the spring LCR population estimates (e.g. LTEMP estimate 1,250 with 5% buffer and addition of 63 fish).

OR

ii. Sub-adult abundance falls below a three-year running average of 851 fish in the mainstem Juvenile Chub Monitoring reach (JCM annual fall population estimate; RM 63.45-65.2; e.g. LTEMP trigger 810 5% buffer and addition of 41 additional fish for buffer).

6) Monitoring will be done in collaboration and cooperation with other ongoing fisheries studies, including those by the Department, the GCMRC, and the Service.

7) The Department will monitor the efficacy of the stocking actions using long-term monitoring methods (creel and fish population trend surveys), and will cease stocking if the goal of 1 fish per hour catch rates occur in the walk-in area is met. Additional parameters of data collection will be included during creel surveys, which may include the use of hand-held PIT tag readers of rainbow trout harvest.

8) The Department will provide an annual report to AESO regarding efficacy of rainbow trout stocking and impacts to humpback chub populations. Data collected from PIT tag tracking will be analyzed GCMRC and Service's Arizona Fish and Wildlife Conservation office along with existing monitoring efforts in the action area. Reporting of this data will occur in coordination with AESO. This information will be shared with stakeholders to aid in management decision.

These measures will provide additional information to provide some benefit to the species potentially affected by the proposed action by minimizing and avoiding impacts to humpback chub from the stocking of triploid rainbow trout. The information regarding new spawning aggregations of humpback chub near 30-Mile Spring will help management of this species, additional information regarding rainbow trout stocking on humpback chub from the 30-Mile Spring area down to the LCR confluence where spawning is documented, and information to be used during decision points to cease stocking should impacts of moving rainbow trout be greater than anticipated. The majority of these measures will provide the tools necessary to minimize and avoid impacts to humpback chub from these stockings that are in excess of what is anticipated. Annual reporting will ensure that stakeholders that have a shared responsibility to co-manage these species in this location will have current and timely information on which they can best make management decisions. The proposed action and resulting conservation measures are designed to provide rainbow trout recreational opportunity in Lees Ferry and conservation benefit to humpback chub through this proposed action.Results of the stocking actions will be evaluated using the goals of the FMP. This action will be in effect for a term of 2 years from the date of the signing of this BO. With the size of the action area and expected lag-time in impact detection (e.g. trout moving downstream over time), a two year time-frame will be sufficient to allow the Department and WSFR to evaluate the efficacy of this action experimentally.

ACTION AREA

The action area is the high water line of the main stem of Colorado River below Glen Canyon Dam from RM -2.5, Lees Ferry, through 30-mile Spring, to the confluence with the LCR at River Mile 77.2 in Grand Canyon National Park. In addition to the Lees Ferry area impacts and

monitoring are expected to occur down the mainstem of the Colorado River to the LCR reach at RM 77.2. For the purposes of this consultation, we analyze impacts to the walk-able (last 2 miles of the Lees Ferry reach) and boat-able (all of Lees Ferry reach sections), and areas where impacts are expected inside both the Glen Canyon National Recreation Area below Glen Canyon Dam and Grand Canyon National Park, down to approximately RM 77.2.

STATUS OF THE SPECIES AND CRITICAL HABITAT

Humpback Chub

The information in this section summarizes the range wide status of humpback chub that is considered in this BO. Further information on the status of these species can be found in the administrative record for this project, documents on our web page (https://www.fws.gov/southwest/es/arizona/) under Document Library, Document by Species, and in other references cited below.

Humpback chub and critical habitat

The humpback chub, an endemic fish to the Colorado River Basin of the southwestern United States, was listed as endangered on March 11, 1967 (32 FR 4001) and the Service designated critical habitat in 1994 (Service 1994). It is native to the states of Wyoming, Colorado, Utah, and Arizona and there are six recognized populations that occur in mid- and low-elevation, canyon-confined, deep-water regions, including five in the upper basin and one in the lower basin (Lees Ferry is the demarcation line between upper and lower Colorado River basins). The upper basin populations occur in (1) the Colorado River in Cataract Canyon, Utah; (2) the Colorado River in Black Rocks, Colorado; (3) the Colorado River in Westwater Canyon, Utah; (4) the Green River in Desolation and Gray Canyons, Utah; and (5) the Yampa River in Yampa Canyon, Colorado. The only population in the lower basin occurs in the Colorado River in Marble Canyon, the Grand Canyon, and LCR. The numbers of individuals in upper basin populations have varied over time, with the three largest populations most recently supporting 404 and 1,315 adults in Black Rocks and Westwater Canyon in 2012, respectively, and 1,672 adults in Desolation/Gray canyons in 2015. The smallest populations are in Cataract Canyon with 468 adults in 2003 to 295 in 2005 and in Yampa Canyon of the DNM population with 320 adults in 2001 to 224 in 2003. Individuals have not been collected in the DNM population since 2004 and it is therefore considered functionally extirpated (Service 2017).

The lower basin population is found in Marble and Grand canyons, with individuals occupying about 400 km (249 mi) of the mainstem Colorado River from RM 30 to RM 280, as well as about 18 km (11 mi) of the lower LCR and about 6 km (3.7 mi) of lower Havasu Creek. The core population (i.e., LCR population) includes fish from the LCR and fish in an area of about 15 km (9.3 mi) of the mainstem around the LCR confluence that move into the LCR to spawn and mix with resident fish (Kaeding and Zimmerman 1983, Valdez and Ryel 1995, Douglas and Marsh 1996). The LCR population of chub, consists of an adult population (abundance for 2009–2012) of about 11,500–12,000 adults (Appendix S3 of Yackulic et al. 2014). Annual spawning in the LCR has not been quantified but could contain millions of fish larvae, with approximately 1% reaching the first year of life. Adult and juvenile chub are detected upstream up through the 30-

mile reach.

Historically, the humpback chub occurred throughout much of the Colorado River and its larger tributaries from below the Grand Canyon upstream into Arizona, Utah, Colorado, and Wyoming (Service 2002). Historical range and abundance levels are unknown. In 1994, the Service estimated that historical range may have included 2,179 km (1,354 mi) of river (Service 1994), but estimates in 2002 and 2011 have been modified to include only canyon-bound reaches of this previously estimated area, estimating an historic range of approximately 756 km (~470 mi) (Service 2002, 2011). Current resource conditions in both the upper and lower basin are fair to good, and are mostly adequate to support the species (Service 2018).

Surveys conducted in 2013, 2014, and 2015 suggest that translocated humpback chub have successfully spawned in Havasu Creek (NPS 2013, Service 2015). Humpback chub occupy approximately the lower 5.6 km (3.5 mi) of Havasu Creek, from the mouth to Beaver Falls, which is a barrier to upstream movement of fish. The most recent humpback chub population estimate in Havasu Creek was approximately 297 individuals as of May 2016; with progressively larger cohorts reported by year (NPS pers. comm. 2018). While reproduction has been documented; the population has increased primarily as a result of continued translocations.

Sampling conducted between October 2013 and September 2014 in western Grand Canyon between Lava Falls (RM 180) and Pearce Ferry (RM 280) captured 144 juvenile humpback chub during sampling of the small-bodied fish community. In addition, 209 humpback chub larvae were collected during sampling of the larval fish community in randomly selected sites (Albrecht et al. 2014). Results were similar in larval and small-bodied fish sampling in 2015: 285 juvenile and 67 age-0 humpback chub were captured during small-bodied and larval fish sampling, respectively, from throughout the study area (Kegerries et al. 2015). These results suggest that young humpback chub are using widespread nursery and rearing habitats between RM 180 and RM 280 in the western Grand Canyon. In the spring of 2017, evidence of reproduction and recruitment was documented at 30-mile. During this survey, over 90 young fish, of varying size classes were documented by the Service and GCMRC (K. Young pers. comm. 2018, and Dodrill pers. comm. 2018).

The LCR aggregation of humpback chub is measured with closed and open population models. Results of these population models indicate that sometime in the mid- to late-1990s, humpback chub underwent a significant decline in the LCR. This was followed by a period of relatively low, but stable abundance between 2000 and 2006, and by a period (2007–2014) of significantly increased abundance levels (Van Haverbeke et al. 2013). The post-2006 increase in humpback chub ≥150 mm and ≥200 mm was visible during both spring and fall seasons, but it was more apparent during spring months. Spring 2015 monitoring showed significant decrease in abundance of humpback chub ≥150 mm and ≥200 mm compared to the previous several years. The cause of this decline is unknown, but there is evidence from sampling in the mainstem during 2015 that many chub may have simply remained or emigrated into the mainstem during 2015 (i.e., the portion of the LCR aggregation of chub residing in the nearby mainstem was higher than usual).

Humpback Chub have expanded in Western Grand Canyon, from near Havasu Creek (RM 158) downstream to below Surprise Canyon (>RM 249). Since 2014, Humpback Chub in Western Grand Canyon have exhibited annual recruitment and increased catch per unit effort (Pillow et al. 2018). This expansion has occurred within and outside of the two recognized aggregations (Havasu Creek and Pumpkin Spring) in this area.

In summary, annual abundance estimates suggest that sometime between the early 1990s and 2000, the abundance of humpback chub ≥150 mm underwent a decline in the LCR (Coggins et al. 2006). This decline was followed by a period of relatively low but stable abundance between 2000 and 2006 and then by a post-2006 period of significant increasing trend and has been relatively stable for about the last five years (Service 2017). A number of factors have been suggested as being responsible for the observed increases, including experimental water releases, trout removal, and drought-induced warming (Andersen 2009, Coggins and Walters 2009). In addition, translocations of juvenile humpback chub to Shinumo and Havasu Creeks have resulted in increased numbers of adult humpback chub captured in the mainstem aggregations (Persons et al. 2017). Translocations to tributaries have been shown to provide an adequate mechanism for rearing juvenile humpback chub that may later disperse to the Colorado River and augment aggregations (Spurgeon et al. 2015).

The humpback chub is a large, long-lived species endemic to the Colorado River system. This member of the minnow family may attain a length of 20 inches, weigh 2 pounds or more, and live for 20 to 40 years (Andersen 2009). The humpback chub evolved in seasonally warm and turbid water and is highly adapted to the unpredictable hydrologic conditions. Adult humpback chub occupy swift, deep, canyon reaches, but also use eddies and sheltered shoreline habitat (Valdez and Clemmer 1982, Valdez and Ryel 1995, Andersen et al. 2010). Spawning occurs on the descending limb of the spring hydrograph at water temperatures typically between 16 and 22°C. Young require low-velocity shoreline habitats, including eddies and backwaters.

The main spawning area for the humpback chub within the Grand Canyon is the LCR, which provides warm temperatures suitable for spawning and shallow low-velocity pools for larvae (Gorman 1994). This healthy population provides substantial redundancy and representation for the species in the Lower Basin. The species spawns primarily in the lower 13.6 km (8.5 mi) of the LCR, but spawning likely occurs in other areas of the Colorado River as well (Valdez and Masslich 1999, Anderson et al. 2010). Spawning and development of young chub has been documented near 30-mile of the Colorado River through Grand Canyon; where multiple, small, size classes have been documented (Anderson et al. 2010, K. Young pers. comm. 2018, Dodrill pers. comm. 2018) or in other areas in the western Grand Canyon following the detection of larval humpback chub in recent years (Albrecht et al. 2014, Kegerries et al. 2015). Gorman and Stone (1999) found ripe adults aggregated in areas of complex habitat structure associated with clean gravel deposits among large boulders mixed with travertine masses in or near runs and eddies.

Young humpback chub seek areas that provide physical cover and contain some velocity refuges, including shoreline talus, vegetation, and backwaters typically formed by eddy return current channels (Department 1996, Converse et al. 1998, Dodrill et al. 2015). Backwaters can have warmer water temperatures than other habitats, and native fish, including the humpback chub,

are frequently observed in backwaters, leading to a common perception that this habitat is critical for juvenile native fish conservation. However, backwaters are rare and ephemeral habitats, so they contain only a small portion of the overall population. Dodrill et al. (2015) demonstrated the total abundance of juvenile humpback chub was much higher in talus than in backwater habitats, which could be a factor of availability of talus habitats versus backwaters. The Near Shore Ecology project concluded that backwaters are likely not important to the LCR chub aggregation because they are not a significant habitat component in that area (Pine et al. 2013).

As young humpback chub grow, they shift toward deeper and swifter offshore habitats. Valdez and Ryel (1995, 1997) found that young humpback chub remain along shallow shoreline habitats throughout their first summer, at low water velocities and depths less than 1 m (3.3 ft.). They shift as they grow larger and by fall and winter move into deeper habitat with higher water velocities and depths up to 1.5 m (4.9 ft.). Stone and Gorman (2006) found similar results in the LCR discovering that as humpback chub physically develop their behavior changes from diurnally active, vulnerable, nearshore-reliant, to nocturnally active, large-bodied adults, which primarily reside in deep mid-channel pools during the day and move inshore at night.

The humpback chub is primarily an insectivore, with larvae, juveniles, and adults all feeding on a variety of aquatic insect larvae and adults, including dipterans (primarily chironomids and simuliids), Thysanoptera (thrips), Hymenoptera (ants, wasps, bees), and amphipods (such as *Gammarus lacustris*) in the Colorado River population (Department 2001). Donner (2011) found that 65% of humpback chub production in the Grand Canyon was attributed to abundant food resources including chironomids and simuliids. Feeding by all life stages may occur throughout the water column as well as at the water surface and on the river bottom. Spurgeon et al. (2015) also found that humpback chub consumed native fish, and that they occupied a high trophic position in the food web in a Grand Canyon tributary, similar to rainbow trout.

Primary threats to the species include streamflow regulation and habitat modification (including cold water dam releases and habitat loss), competition with and predation by nonnative fish species, parasitism, hybridization with other native *Gila*, and pesticides and pollutants (Service 1990, 2002). Upper basin habitat, including channel geomorphology and water temperature have not changed appreciably, but spring peak flow has been reduced, while summer and winter base flows have increased. Habitat in the Grand Canyon has been modified by the presence and operation of Glen Canyon Dam, including altered flow, temperature regimes, and sediment budget. Predation and competition by nonnative fishes is likely the greatest threat to both upper basin and lower basin populations.

Recovery for the humpback chub is defined by the Service Humpback Chub Recovery Goals (Recovery Goals) (Service 2002). The Recovery Goals consist of actions to improve habitat and minimize threats. The success of those actions is measured by the status and trend (i.e., the demographic criteria) of the population. The Service, the Glen Canyon Dam Adaptive Management Program (GCDAMP), and the Upper Colorado River Endangered Fish Recovery Program (UCRRP), the programs that address conservation of all of the upper Colorado River basin populations of humpback chub, use the underlying science in the Recovery Goals. A 5-Year Review conducted in 2011, relied on the information provided in the recovery goals and provides supplemental information on the species' distribution and status (Service 2011), with an

additional 5-year review and recommendation for down listing to threatened in 2018 (Service 2018).

Critical Habitat

Critical habitat for humpback chub was designated in 1994 in seven reaches for a total of 610 km (379 mi) (Service 1994). There are 319 km (198 mi) of critical habitat in the upper basin (Colorado and Utah) and 291 km (181 mi) in the lower basin (Arizona). In Arizona, critical habitat includes 278 km (173 mi) of the Colorado River through Marble and Grand Canyons (Reach 7) from Nautiloid Canyon (RM 34) to Granite Park (RM 208), and the lower 13 km (8 mi) of the LCR (Reach 6). The entire Colorado River reach in Arizona and the bottom portion of the LCR are within the action area for this proposed action.

Critical habitat was designated for the four big river fishes (Colorado Pikeminnow [*Ptychocheilus lucius*], humpback chub, bonytail chub [*Gila elegans*], and razorback sucker) concurrently in 1994, and the primary constituent elements (PCEs) were defined for the four species as a group (Service 1994). However, the PCEs vary somewhat for each species on the ground, particularly with regard to physical habitat, because each of the four species has different habitat preferences. The PCEs are:

- Water: Consists of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered in sufficient quantity to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species.

- Physical Habitat: This includes areas of the Colorado River system that are inhabited by fish or potentially habitable for use in spawning, nursery, feeding, or corridors between these areas. In addition to river channels, these areas include bottomlands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.

- Biological Environment: Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. Predation, although considered a normal component of this environment, is out of balance due to introduced fish species in some areas. This is also true of competition from nonnative fish species.

The PCEs are all integrally related and must be considered together. For example, the quality and quantity of water affect the food base directly because changes in water chemistry, turbidity, temperature, and flow volume all affect the type and quantity of organisms that can occur in the habitat that are available for food. Likewise, river flows and the river hydrograph have a significant effect on the types of physical habitat available. Changes in flows and sediment loads caused by dams may have affected the quality of nearshore habitats utilized as nursery areas for young humpback chub. Increasingly the most significant PCE seems to be the biological

environment, and in particular predation and competition, from nonnative species. Even in systems like the Yampa River, where the water and physical PCEs are relatively unaltered, nonnative species have had a devastating effect on the ability of that critical habitat unit to support conservation (Finney 2006, Fuller 2009). It is likely that the future conservation of humpback chub may depend on our ability to control nonnative species, and manipulating the water and physical PCEs of critical habitat to disadvantage nonnatives may play an important role.

Previous Consultations

Section 7 consultations on humpback chub have evaluated large-scale water-management activities. For the upper basin, UCRRP tracks the effects of such consultations on the species and provides conservation measures to offset the effects. Several consultations have occurred on the operations of Glen Canyon Dam, including one in 1995 that resulted in a jeopardy and adverse modification opinion. Subsequent consultations in 2008, 2009, and 2010 reached non-jeopardy/non adverse modification conclusions. Finally, the Grand Canyon NPS has consulted on their Comprehensive Fisheries Management Plan (NPS 2013) and the Bureau of Reclamation completed consultation on their Glen Canyon Dam LTEMP (Reclamation 2016) which focuses on impacts of Dam operations. Biological opinions on actions potentially affecting humpback chub in Arizona may be found at our website https://www.fws.gov/southwest/es/arizona/ in the Section 7 Biological Opinion page of the Document Library.

ENVIRONMENTAL BASELINE

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

Status of the species and potential habitat within the action area

Humpback chub

The Lower Colorado River Basin population of humpback chub is the largest of the six population centers of the humpback chub (Service 2011) and is found in the Colorado River and LCR 60 mi (96.6 km) downstream Glen Canyon Dam, with detections of adult and recent spawning and recruitment of young humpback chub occurring 30 miles (48.28 km) downstream of Glen Canyon Dam and Lees Ferry. Within the Grand Canyon, this species is most abundant in the vicinity of the confluence of the Colorado River and LCR (Kaeding and Zimmerman 1983, Douglas and Marsh 1996, Valdez and Ryel 1995). This population is specifically referred to as the LCR aggregation of humpback chub and includes those fish residing in the LCR and in the mainstem within approximately 15km (9.3 mi) of the LCR mouth. In addition, some of the eight other areas (aggregation areas) where humpback chub are, or have been, regularly collected within the action area. These aggregation areas include the mainstem at 30 Mile, and other areas

below the Action Area including Lava Chuar-Hance, Bright Angel Creek inflow, Shinumo Creek inflow, Stephen Aisles, and Middle Granite Gorge (Valdez and Ryel 1995, Ackerman 2008, Persons et al. 2017). In addition, since 2009, translocations of humpback chub have occurred to introduce juvenile fish into Shinumo and Havasu Creeks, with the goal of establishing additional spawning populations within the Grand Canyon (NPS 2013). Healthy, annual spawning has been documented in the LCR with young of year moving into the mainstem Colorado River. Sub-adult abundance is stable overall and is not expected to drop below a three-year running average of 1,500 fish during the spring LCR population estimates; in addition the adult population has been stable for the past 5 years, indicating a self-sustaining and possibly growing population (Service 2018).

Critical habitat

Critical habitat for humpback chub in the action area includes a portion of Critical Habitat Reach 6, the LCR, and portions of Critical Habitat Reach 7, the Colorado River in Marble and Grand Canyons. Reach 6 consists of the lowermost 8 mi (13 km) of the LCR to its mouth with the Colorado River. Reach 7, consists of a 173-mile (278-km) reach of the Colorado River in Marble and Grand Canyon from Nautiloid Canyon (RM 34) to Granite Park (RM 208). Stocking of rainbow trout is proposed to occur in Lees Ferry just upstream of the Critical Habitat boundary; however, resulting movement of a small portion of the stocked rainbow trout into humpback chub occupied areas is anticipated in Critical Habitat Reach 7 down to RM 77.2.

The current condition of critical habitat in the LCR (Reach 6) is probably similar to historical conditions in many ways. All of the PCEs are provided for in this reach of humpback chub critical habitat, and this segment supports the majority of the Grand Canyon population, the largest of the humpback chub populations.

Critical habitat in Reach 7, in Marble and Grand canyons, has been altered significantly from historical conditions, primarily due to the construction and operation of Glen Canyon Dam and the presence of nonnative aquatic species (Service 2011). The flow of the Colorado River in Marble and Grand canyons has been modified by Glen Canyon Dam since 1964, and the dam and its operation is the primary factor in the function of PCEs in this reach. However, humpback chub use a variety of riverine habitats, with adults found in canyon areas with fast current, deep pools, and boulder habitat, and at least some of the PCEs are functional as demonstrated by the persistence of mainstem aggregations of humpback chub. Reach 7 serves an important role in support of the Grand Canyon population although the relationship with the LCR and the overall importance of habitats in the mainstem to recovery is not well known. This is because most of the humpback chub population occurs in the Little Colorado inflow aggregation, which uses the LCR to a large degree.

Dam discharge and river flow regimes can both destroy and build shoreline rearing habitat, thus affecting juvenile chub survival (Converse et al. 1998). Fluctuating flows can destabilize backwater habitats and may negatively impact aquatic macroinvertebrate production (Kennedy et al. 2016). However, dam releases, such as High Flow Experiments (HFEs), can create shallow backwater habitats associated with sandbars and are thought to provide rearing habitat for native fish, because they may be warmer than the mainstem river water temperature during the summer

months due to solar radiation (Behn et al. 2010, Dodrill et al. 2015). Although HFE water releases from Glen Canyon Dam between 2000 and 2008 may have improved some habitat characteristics (e.g., backwaters) for humpback chub, the limited availability of suitable warm water temperatures in the mainstem may have constrained the potential for positive population responses (Kennedy and Ralston 2011). Additional factors affecting the PCEs of critical habitat are discussed below.

The PCEs, as described in the Status of the Species section, are: Water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity) that is delivered to a specific location in accordance with a hydrologic regime required for the particular life stage for each species; Physical Habitat, areas for use in spawning, nursery, feeding, and movement corridors between these areas; and Biological Environment, food supply, predation, and competition. In summary, the conditions of the PCEs in Reach 7 are:

- The physical PCE for spawning is present within critical habitat Reach 7. During the early 1990s, nine aggregations of humpback chub were described in Grand Canyon (Valdez and Ryel 1995). These comprised the aggregations at 30-Mile and LCR. Critical habitat has supported additional small aggregations, ranging from 5-98 adult humpback chub per aggregation. Population estimation was not provided for some of the aggregations because of too few recaptured fish (Valdez and Ryel 1995). This trend of low catch in aggregations outside of the LCR aggregation continued during 2002-2006, although the pattern was reported as low relative abundance (catch per unit effort, CPUE) rather than absolute abundance (Ackerman 2008). Since 2010, annual sampling of the aggregations has again resumed. Major findings have been that relative abundances of adult humpback chub in the aggregations have increased since sampling events during the earlier time periods (Persons et al. 2017). Additionally, a group of adult chub likely consisting of between 300-600 individuals has been found near 34-Mile in Marble Canyon (D. Van Haverbeke 2016, pers. comm.), and there appears to have been a dramatic increase in abundances of humpback chub in western Grand Canyon (Havasu Creek and below), with all size classes being represented (Pillow et al. 2018).

- Nursery habitat for juvenile humpback chub may be limited by fluctuating flows that alternately flood and dewater mainstem near shore habitats important to early life stages of humpback chub and by the loss of sediment-formed habitats. Feeding areas are available to all life stages, especially for adult fish as indicated by condition factor of adult fish in the mainstem compared to those in the LCR (Hoffnagle et al. 2006), although feeding areas in the mainstem may be limiting for juvenile humpback chub due to the effect of fluctuations on nearshore habitats (Department 1996). There is evidence of expansion of this population of humpback chub, spawning, survival and growth, upstream near 30-Mile spring (Pers. comm. January 9, 2018, GCMRC and Service).

- Movement corridors appear to be adequate based on movements of humpback chub throughout the system (Valdez and Ryel 1995, Paukert et al. 2006).

- Food supply is a function of nutrient supply, productivity, and availability to each life stage of the humpback chub. River regulation by Glen Canyon dam decreases turbidity in

the tail waters (the water immediately downstream of a dam) and permits increased algae growth on bottom substrates (Angradi 1994, Shannon et al. 1994), leading to an increased expansion of macroinvertebrate populations in the tail water reach of Glen Canyon Dam (Blinn et al. 1993, Stevens et al. 1997). Algae biomass and production decrease downstream as water clarity decreases (Carothers and Brown 1991, Stevens et al. 1997, Hall et al. 2010). This drives a downstream decrease in aquatic invertebrate biomass (e.g., midges, snails, and aquatic worms) (Carothers and Brown 1991, Stevens et al. 1997, Kennedy and Gloss 2005, Rosi-Marshall et al. 2010). Cold water temperatures and daily fluctuations in discharge associated with hydropower production are likely responsible for the low diversity and abundance of aquatic insects downstream of the Paria River (Stevens et al. 1997, Kennedy et al. 2016).

- Nonnative fish species that prey on and compete with humpback chub affect the PCEs of the biological environment aspect of critical habitat. Catfish (channel catfish and black bullhead), trout (rainbow and brown trout), and common carp are well established in the action area and will continue to function as predators or competitors of humpback chub. Minckley (1991) hypothesized that nonnative fish predation and competition may be the single most important threat to native fishes in Grand Canyon (Valdez and Ryel 1995, Marsh and Douglas 1996, Coggins 2008, Yard et al. 2008). In 2015 and 2016 green sunfish were detected in a slough in the Lees Ferry reach of Glen Canyon and brown trout appear to be fluctuating in this reach as well. Partner agencies treated the slough with piscicides in 2015 and 2016 to remove the green sunfish (*Lepomis cyanellus*), but it is likely invasions of nonnative, predatory fish will continue. Currently, there is evidence that population of brown trout (*Salmo trutta*) in Lees Ferry is present and fluctuating.

- The water quality and quantity PCEs in Reach 7 have been modified by Glen Canyon dam by altering water temperatures and flow regimes. However, since 1996, water releases from Glen Canyon Dam have been adaptively managed to improve water quality and quantity for humpback chub in the Colorado River through Grand Canyon (Reclamation 1996). These modified flows (specifically, MLFF) reduced daily fluctuations in river flow from peak power plant releases, and allowed for higher spring releases to restore some aspects of the natural hydrograph. These flow actions appear to be assisting with maintenance of this PCE, with the caveat that the requirements necessary for all life stages of humpback chub in the mainstem to support a recovered Grand Canyon population are still under investigation (Service 2011). Brown trout control has been successfully implemented in and near Bright Angel Creek (Healy et al. 2018).

B. Factors affecting species environment and critical habitat within the action area

Primary factors affecting humpback chub and critical habitat within the action area include habitat alterations associated with dams and reservoirs that have modified water temperature, and the introduction, and expansion, of nonnative fishes (Service 2011), which act as competitors and/or predators of the humpback chub (Andersen 2009, Yard et al. 2011, Kennedy et al. 2013).

- Temperatures, particularly in the upper reaches of the action area, even in warmer years, are not optimal for humpback chub spawning and growth. The cold water temperatures in most places of the main channel are below the temperature needed for spawning, egg incubation, and growth of the humpback chub. Survival of humpback chub young in the mainstem near the LCR is thought to be low because of cold mainstem water temperatures (Clarkson and Childs 2000, Robinson and Childs 2001), which may limit hatching success, reduce larval survival and larval and juvenile growth, reduce swimming ability, and increase predation vulnerability (Ward and Bonar 2003, Ward 2011). Water temperatures in the mainstem Colorado River have generally been warmer over the last decade, and warming over the summer increases downstream, due to solar radiation. These warmer water temperatures in the mainstem over the last decade may be providing some temporary benefit and contributing to the improving status of the humpback chub (Reclamation 2011). For example, maximum daily temperatures exceeded 68°F in the lower river (RM 180–RM 280), and daily average temperature was 64°F below the action area in early July (Kegerries et al. 2015). The evidence of recruitment at the 30-mile aggregation possibly due, in part, to the presence of warm springs. Adult chub captured near RM 35, and small size classes of chub found at 30-mile suggests recruitment and possibly an expansion of the 30-mile aggregation.

- Nonnative fishes including wild rainbow trout piscivory has been studied in the Lower Colorado River basin, including impacts to humpback chub young. Rainbow trout in the Grand Canyon exhibit slower growth in months when turbidity is high for example with inputs from the Paria and Little Colorado River (Yard et al. 2015); smaller rainbow trout are likely due to reduced foraging success (Sweka and Hartman, 2001, Ward, 2018 in press). Ward (2018 in press) demonstrated that hatchery reared rainbow trout consumed between 22-47% fewer young chub than wild-born counterparts and that the successful catch of larval chub decreased as turbidity increased under captive research conditions. However, although consumption was lower, the attempt of rainbow trout to forage was still existent, resulting in trout chasing young chub. Although chasing does not always result in a successful catch, it has the potential to result in energy expenditures of larval humpback chub that would not happen unless they were being chased, which could lead to reduced fitness and survival. Additionally, hatchery reared rainbow trout become more efficient over time in this study (Ward 2018 in press). Ingestion of humpback chub eggs by trout has not been studied, but it cannot be ruled out. Yard et al. (2011) documented rainbow trout consume native fish disproportionally to their availability in the Colorado River, in areas where humpback chub aggregations exits. They estimated that a range of 1,232-1,826 humpback chub were consumed each year by wild rainbow trout near the LCR confluence, between 2003 and 2004. Under specific environmental conditions (such as temperature and density of fish) and an increase of rainbow trout abundance from 800 to 1,750 (roughly 46% increase) could lead to a 23% decline in annual survival of humpback chub probability (Yackulic et al. 2018).

- The incidence of piscivory by brown trout has been found to be much higher than for rainbow trout in the Grand Canyon (Yard et al. 2011, Whiting et al. 2014), but rainbow trout are much more abundant in the Colorado River, and thus may impact native fish at a similar magnitude or greater (Yard et al. 2011). Predation by channel catfish and black

bullhead are also thought to impact humpback chub in the Grand Canyon, particularly if warmer water conditions occur (NPS 2013). Because of their size, adult humpback chub are less likely to be preyed on by trout; however, emergent fry, young-of-year (YOY), and juvenile humpback chub are susceptible to predation in the LCR and mainstem Colorado River (Yard et al. 2011). There is evidence of density dependent movement of rainbow trout and a negative relationship of number of rainbow trout and survival and growth of juvenile humpback chub (Yackulic et al. 2018).

In addition, the Colorado River includes nonnative fish parasites, such as the Asian tapeworm and anchor worm, which may infect some humpback chub and affect survival (Clarkson et al. 1997, Andersen 2009). Recent studies also indicated that toxic mercury (Hg) and selenium (Se) concentrations in native fish were elevated in the Grand Canyon (Walters et al. 2015). While humpback chub were not tested in the study, elevated levels of Hg in the food web, and in particular, primary prey items, including blackfly larvae (Simuliidae), may result in negative impacts to humpback chub (Walters et al. 2015).

The lower Colorado River including the action area has been subject to the effects of Federal, State, and private activities for over 120 years. The greatest changes have come in the last 80 years, with the construction of large dams. Impacts of these human activities along the river have had profound effects on the river, associated riparian and floodplain areas, and the aquatic fauna. The Colorado River below Glen Canyon Dam releases water for a multitude of resources but primarily for hydropower generation and water delivery. A number of monitoring and research efforts are underway in and throughout the action area as a result of the National Park Service, including their Comprehensive Fisheries Management plan; and the LTEMP, managed by the Bureau of Reclamation, and other biological, cultural, and recreational programs that work in concert to provide management and balance of shared resources. Actions resulting, and outlined, in previous and ongoing consultation for the Lower Colorado River Basin population of humpback chub include Reclamation's LTEMP (2016), NPS' Comprehensive Fisheries Management Plan (2014), and NPS' Nonnative Aquatic management plan (in development). All of these actions take into account their complex impacts to humpback chub and focus on conservation to the species to such a level that it does not jeopardize the species existence. Additional protection and impacts come from actions outlined in the body or documents referred to as the Law of the River, including the Grand Canyon protection act. Consideration of native fishes will continue to be a priority and will continue during the life of the project.

EFFECTS OF THE ACTION

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

General Rainbow Trout Background Information

Rainbow trout are originally native to western North America, primarily from the coastal streams of the Northwest; however not native to the Colorado River. It is one of the most intensively cultured fish throughout the world and is one of the most economical trout to produce, making it a substantial component of cold water sport fishing programs. They were first introduced into Arizona in 1899, and few self-reproducing populations exist in the wild, with the Lees Ferry population being one of these. Rainbow trout inhabit cool clear lakes and cool-water streams with larger substrates (gravel/boulder). In New Mexico, rainbow trout are found in streams with pool-to-riffle ratios of 1:1 (Sublette et al. 1990). Deep, low velocity pools are important overwintering habitat and instream cover (overhanging banks, submerged vegetation, log jams, and boulders) is an essential habitat component for escape and resting cover (Sublette et al. 1990).

The species is tolerant of a range of stream conditions including water temperatures from 0°C to the upper incipient lethal temperature for adults of 25°C (Embody 1934, Carlander 1969, Piper et al.1982, Raleigh et al. 1984) and a pH range of 5.8-9.6. However, the optimal conditions for growth are 13 – 21°C, slightly alkaline waters (pH of 7-8), and ≥ 7 ppm dissolved oxygen concentrations at temperatures ≤ 15°C, and ≥ 9 ppm dissolved oxygen at temperatures ≥ 15° C (Raleigh et al. 1984).

Rainbow trout can be territorial, and will aggressively defend feeding areas (Sublette et al. 1990). They are primarily stream spawners and require tributary stream with gravel substrate in riffle areas for successful reproduction. Trout that spawn in lakes with inlet and outlet stream may spawn as much as one month earlier in the outlet than the inlet due to temperature differences. The proposed action of stocking of rainbow trout will use sterile triploid trout to avoid spawning and aid in management of rainbow trout density. Although aggressive territoriality of rainbow trout in foraging areas may occur, defense of spawning areas will not because stocked fish will not spawn.

Rainbow trout movement and dispersal on big rivers has been studied and we use this information in our analysis of estimated out-migration rates for the proposed stocking. Downstream movement may vary by habitat type (lentic versus lotic systems) and by strain (Moring 1993). Ninety-five percent of the catchable triploid rainbow trout stocked in the Middle Fork of the Boise River, Idaho, was located within 3 km (1.9 mi) of the stocking point (High and Meyer 2009). Similar results of movement for catchable trout were reported in Idaho's upper Salmon River, where more than 90% of the reported recaptures were within 3.2 km (2 mi) of the stocking site (Bjornn and Mallet 1964), and in the Portneuf River, where 66% of tagged catchable trout were captured within a few hundred meters of the stocking location (Heimer et al. 1985). Catchable Rainbow Trout stocked in a tail water fishery moved an average of only 1.4 km (0.9 mi) in July and 3.8 km (2.4 mi) in September within 24 hours after stocking (Bettinger and Bettoli 2002). This lack of dispersal concurs with other studies, where, in general, catchable trout disperse no more than about 1 km (0.62 mi) (Helfrich and Kendall 1982).

While there is literature supporting the assumption that catchable Rainbow Trout will remain within a few kilometers of the stocking point, some sources have documented

occurrences of hatchery-raised Rainbow Trout moving longer distances downstream. High and Meyer (2009) documented a maximum downstream movement in the Middle Fork Boise River of 15.6 km (9.69 mi). Bjornn and Mallet (1964), documented a maximum downstream movement of 27.4 km (17.02 mi) in the upper Salmon River, and 158 km (98.18 mi) in the Portneuf River was reported by Heimer et al. (1985). Moring (1993) suggested a sizable portion of stocked populations (approximately 22%) frequently move >12 km (7.5 mi) and average 1.1 – 1.7 km (0.7 – 1.1 mi) a day. However, few fish (<1%) had moved > 35 km (>21.7 mi) downstream over four years, most moved < 15 km (<9.3 mi).

Some stocked rainbow trout are expected to move away from areas in which they are stocked. Their behavior in streams shows a combination of long range movements and restricted movements in any given population. Individual fish will also show signs of switching these behaviors. Furthermore these behavior combinations are presumably adaptive when conditions are often unpredictable and changeable. These movements demonstrate the possibility of trout moving into areas where humpback chub are persisting and spawning, and potentially resulting in disruption of humpback chub spawning behavior or predation on small, larval humpback chub.

The survival and persistence of catchable-sized trout (8-14 inches) stocked for sport fishing has been evaluated in several studies. Fifty-percent of hatchery-raised brown trout stocked into Norway streams were caught within 15 days, and 90% within 67 days (Skurdal et al. 1989). Rainbow trout can live up to 11 years, with 5 – 7 years being typical; some stocked fish are likely to survive for a full lifetime, although this number may be relatively small. High to moderate mortality is also a typical finding from other studies, where stocked trout are generally either angled or experience natural mortality soon after stocking (Bachman 1984, Skurdal et al. 1989).

Annual survival of catchable stocked triploid Rainbow Trout is generally expected to be low. Dillon et al. (2000) documented survival rates at only 2- 3% for hatchery-raised catchable trout in 18 Idaho rivers and streams. Studies have shown stocked catchable trout in rivers and streams experience greater than 95% annual mortality (Miller 1952), and persist less than a few months post-stocking (Bettinger and Bettoli 2002, Quinn and Kwak 2011). High and Meyer (2009) documented persistence of stocked catchable trout was less than three months. In most rivers, these fish may not contribute to the fishery over multiple years, but they are valuable in providing short-term angler opportunity. In general, the high natural mortality rate observed in stocked trout is suggested to result from a combination of the following: stocked trout are poorly adapted to stream environments, competition with resident trout populations, high stocking densities, warming water temperatures, foraging techniques and natural feed, appropriate energy expenditures, and seasonal dominance hierarchies associated with drift feeding and territory establishment (Bachman 1984). Stand alone or combined, these adaptations may result in malnutrition and subsequent mortality of stocked trout. Warm water temperatures have also been implicated as the primary cause of mortality of stocked trout (Runge et al. 2008); however, temperatures are currently cool enough in the action area to support rainbow trout survival.

Predation by rainbow and brown trout at the LCR confluence has been identified as an additional mortality source affecting humpback chub survival, reproduction, and recruitment (Valdez and

Ryel 1995, Marsh and Douglas 1997, Yard et al. 2011, Yackulic 2018). Rainbow trout are opportunistic feeders and their primary food items depend in part on the life history stage of rainbow trout as well as the habitat being used. Juveniles and adults feed on terrestrial and aquatic insects and other aquatic invertebrates such as nematodes, leeches, annelids, gastropods and other mollusks, benthic and planktonic crustaceans (cladocerans, isopods, amphipods, shrimp, and crayfish), small ray-finned fishes, fish eggs and larvae, detritus, benthic algae, and occasionally lizards, mice, and bats (Montgomery and Bernstein 2008).Young fish feed on immature and emergent aquatic insects and will continue to take insects but become piscivorous when larger (Raleigh et al. 1984, Sublette et al. 1990). In streams, rainbow trout feed primarily on drift organisms. In lakes, they prefer benthic invertebrates and zooplankton (Sublette et al. 1990). During extended periods of low food availability, trout will often exhibit hyperphagia and considerable compensatory growth following these stressful periods (Jobling and Koskela 1996). Sweetser et al. (2002) found rainbow trout to be the least piscivorous of three trout species (brown, brook, rainbow) they examined in the LCR in Arizona. Bryan et al. (2000) noted that rainbow trout can adversely affect native fish populations through aggressive displacement through interference competition, using resources more quickly and efficiently through exploitative completion, increasing stress hormones, or by opportunistic piscivory. Bonar et al. (2004) considered rainbow trout to be a less significant piscivore in the Verde River with less than 4% of fish in their diet spite of their statement that continued stocking has the "potential to impact abundance and distribution of native fish due to their stocking overlaps with the peak of spawning activities by native fishes." Competitive interactions of rainbow trout with various fish may be weakened in warm waters (Montgomery and Bernstein 2008). However, evidence of piscivory in rainbow trout has been documented at varying levels and piscivory is demonstrated more frequently in lacustrine habitats compared with fluvial habitats. For example, Hubert et al. (1994) found evidence of piscivory in 1.5% of stocked rainbow trout from Lake DeSmet, Wyoming. Stocked rainbow trout in Flaming Gorge Reservoir, Utah, primarily consumed macroinvertebrates and only switched to limited piscivory at large sizes that accounted for 2.5 - 8% of trout diets (Haddix and Budy 2005). Elser et al. (1995) documented piscivory in 1% of rainbow trout (n = 4/400) in Castle Lake, California. In contrast, evidence of piscivory in native populations of cutthroat trout in Lake Washington, Washington, was found in 22.5% of trout less than 200 mm and in 95% of trout greater than 400 mm (Nowak et al. 2004).

Studies also show rainbow trout in stream settings may exhibit rare piscivory. For example, rainbow trout in Green River, Utah were primarily insectivorous and piscivory was rarely documented (0.4% n=2/478; Filbert and Hawkins 1995). Documentation of piscivory in rainbow trout across Arizona and New Mexico streams has ranged between 4-9%, with diets primarily consisting of invertebrates (Propst et al. 1998, Robinson et al. 2000, Bonar et al. 2004).

Effects to Humpback Chub

We evaluate impacts that triploid rainbow trout have on the Grand Canyon population of humpback chub, which is driven by density and movement of rainbow trout in the action area (Yackulic 2018). Stocked rainbow trout movement out of Lees Ferry has not been studied. As conservation measures are employed, managers will be able to detect behavioral differences between movements of wild versus stocked rainbow trout with fin clips and pit tags. Density dependent movement of rainbow trout has been documented in the Lees Ferry reach. Reduction

in trout abundance in the Lees Ferry reach may reduce downstream dispersal into reaches where humpback chub are located (Avery et al. 2015, Yard et al. 2015, Yackulic et al. 2018). Trout numbers are currently low but will be augmented by the proposed action. Another example of density dependent impacts to the Grand Canyon population of humpback chub showed a strong negative relationship between density of rainbow trout and survival of chub; meaning the higher the density of trout, the lower the numbers of juvenile humpback chub (Yackulic et al. 2018).

The proposed action is to stock 16,000 tagged sterile triploid rainbow trout annually in 2018 and 2019, with no more than 5,000 stocked in any given month, into Lees Ferry. This number of stocked rainbow trout is a fraction of the overall estimated number of wild rainbow trout in the action area. The Department estimates that there are 375,000 rainbow trout in Lees Ferry alone. It was estimated in 2016 that there were over 1 million wild rainbow trout in the Colorado River from Glen Canyon through Grand Canyon National Park total. It is anticipated that the proposed stocking will contribute an additional 4.3% of the existing wild rainbow trout population in Lees Ferry alone and 1.6% of the wild trout population in the entire Colorado River in Glen and Grand Canyon, including action area.

It is anticipated that predation of humpback chub by triploid rainbow trout is without significant consequence at the population level under the current fish community structure. However individual humpback chub will experience mortality due to predation of small humpback chub by stocked rainbow trout. There will not be a significant increase in the overall estimated percentage of rainbow trout as a result of this action overtime, because most stocked rainbow trout are not expected to survive beyond one year. More important, the stocked triploid trout will not reproduce, or contribute to long-term management of numbers of overall trout in the system.

Impacts to humpback chub are expected to be minor at the stocking site since very few humpback chub persist in the Lees Ferry portion of the river. However the stocked trout will disperse in the river, increasing the likelihood of competition and predation. We know little about the differences of outmigration rates, or predation rates, of stocked triploid rainbow trout compared to their wild-born counterparts from Lees Ferry to either the 30-Mile Spring area or down to the confluence with the LCR, therefore we use estimates of movement of the wild rainbow trout from Lees Ferry to areas occupied by humpback chub downstream. Given the wild trout information, we anticipate that some stocked rainbow trout will move out of the Lees Ferry area either upstream or downstream toward the 30-Mile Spring and LCR confluence area. Monitoring efforts will attempt to quantify the number of rainbow trout that move downstream. Agency population modeling has anticipated the number to be around 170 to 185 trout per year (accounting for error rates in estimate), not accounting for differential survival and predation rates between wild and stocked trout. Using this estimate, we then estimated that predation of humpback chub would be similar to wild versus stocked rainbow trout for this geographic area, and result in approximately 40 individual humpback chub larvae and young of year being consumed annually as a result of stocked rainbow trout (see Appendix B for full description of estimate). This predation rate is less than 1% of any year class, or roughly 0.3%. Rainbow trout stocking will coincide with humpback spawning in the mainstem or tributaries, resulting in larval humpback chub co-occurring where stocked trout may have dispersed. Nevertheless, given the limited overlap of the two species, we expect the overall impact to the 2018 or 2019 humpback chub year to be low. Monitoring and conservation measures are in place to confirm the numbers

of stocked trout; further the stocked rainbow trout are not expected to live past year 3, and most are expected to die in the first year. Although loss of larval humpback chub is expected, the adult population of humpback chub currently has a population estimate of 12,000 adults and is expected to persist during the life of this project.

Harassment of spawning humpback chub adults by stocked rainbow trout and some direct predation on small (larval and young of year), and perhaps eggs, of humpback chub is anticipated. Foraging competition may also occur, since the diets of humpback chub and rainbow trout overlap. Additional take in the form of harassment of all life stages of humpback chub, by stocked rainbow trout, is also expected to occur. This harassment may be in the form of non-lethal harassment of humpback chub by rainbow trout to such an extent that behavioral modification of avoiding rainbow trout might reduce individual humpback chub to shelter, forage, or breed, and could result in decreased fitness of individuals.

Piscivory has been documented by wild rainbow trout in the Lower Colorado River basin, and in particular for piscivory impacts to humpback chub young. Although consumption of YOY may be lower with stocked rainbow trout, the need to forage will still existent, resulting in trout chasing young chub. Even if chasing does not result in a successful capture, it has the potential to result in energy expenditures of larval humpback chub, which could lead to reduced fitness and survival. Additionally, Ward (2018) found hatchery reared rainbow trout become more efficient at catching prey over time in this study (Ward 2018). Ingestion of humpback chub eggs by trout has not been studied, but it cannot be ruled out as a form of take. Given Yard et al.'s (2011) documented work on rainbow trout's disproportionally consumption of native fish in relation to the areas where humpback chub aggregations exits, piscivory is expected to continue with the proposed action. .

Because of the current population estimate of adult humpback chub and with the amount of predation of humpback chub being relatively miniscule to the overall population, the presence of 16,000/year triploid rainbow trout would not lead to population level impacts of humpback chub. Additionally, a resilient population of adult humpback chub relies on a larger number of larvae for population's resiliency and stability. This amount of larval loss should be easily overcome by compensatory mortality on a system with its current carrying capacity sustaining an adult population of such a large size, as relatively high juvenile mortality is expected for this long-lived fish (Pine et al. 2013). Although predation of small sized humpback chub is anticipated to occur as a result of this stocking, it is not anticipated that it will result in a population level impact, and conservation measures are in place to cease stocking at an early stage if it appears that impacts of the action are greater than anticipated. The conservation measures in the proposed action are designed to protect humpback chub resiliency and support continued efforts towards species conservation and recovery. The Lower Colorado River Basin population of humpback chub is estimated to be abundant (around 12,000 adult individuals) and self-sustaining (Service 2018). Because the current population of adult humpback is high and stable, and because the proposed action outlines measures to cease stocking once a conservative number of stocked rainbow trout have moved into areas where humpback chub are detected, the population level impacts to this humpback chub population is not expected to result in permanent long-term population losses.

Humpback Chub Critical Habitat

In our analysis of the effects of the action on critical habitat, we consider whether or not a proposed action would result in the destruction or adverse modification of critical habitat. In doing so, we must determine if the proposed action would result in effects that appreciably diminish the value of critical habitat for the recovery of a listed species. To determine this, we analyze whether the proposed action would adversely modify any of the PCEs that were the basis for determining the habitat to be critical. To determine if an action results in adverse modification of critical habitat, we considered the current condition of all designated critical habitat units for this species, to determine the overall ability of all designated critical habitat to support recovery. Further, the functional role critical habitat in recovery must also be considered as it represents the best available scientific information as to the recovery needs of the species.

Nonnative fish species that prey on and compete with humpback chub affect one of the PCEs of the biological environment aspect of Critical Habitat. Nonnative fish predation and competition is an important threat to native fishes in Grand Canyon (Minckley 1991, Valdez and Ryel 1995, Marsh and Douglas 1996, Coggins 2008, Yard et al. 2008, Yackulic et al. 2018) including humpback chub. Stocking of nonnative rainbow trout inherently impacts this PCE as outlined under critical habitat for humpback chub. Under the factors listed for the biological environment, areas with no, or low numbers of nonnative fish are preferred. The addition of nonnative species, which will prey on and compete with humpback chub, impacts this one PCE by definition, consistent with the analysis provided above. However, impacts to all PCEs must be considered collectively when analyzing adverse modification, and impacts to Critical Habitat.

We do not have evidence that stocking of triploid rainbow trout will impact any other PCE except for putting additional nonnative fish that may prey on and compete with humpback chub for food and other resources. One example of this is that stocking of rainbow trout is not anticipated to impact water quality or quantity. The proposed action is also not likely to significantly alter food resources or the nonnatives' fish assemblage presently occurring in the area. However, given the size of the action area, the number of trout proposed to be stocked over the 2-year period, their ability to reproduce, the anticipated estimated level of movement of stocked rainbow trout into designated Critical habitat, and current nonnative fish assemblage that is present in the area, we anticipate that proposed stocking of rainbow trout will not appreciably diminish the conservation value of critical habitat for humpback chub under current environmental conditions.

Additionally, should movement of stocked rainbow trout be higher than anticipated, monitoring is in place to document this occurrence, and the stocking action will cease, ensuring no unintended impacts or additional impacts to the conservation value of the Critical Habitat. Finally, other ongoing conservation measures, and a robust research and monitoring plan associated with LTEMP and other efforts are in place, to ensure the conservation of the humpback chub and other native fishes. The proposed action is not expected to further diminish the conservation contribution of critical habitat to the recovery of the humpback chub.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

This portion of the river is managed by the National Park Service and Bureau of Reclamation, and Tribal partners, requiring Federal permits or authorization, which would be subject to Section 7 consultation. For example, NPS is currently working on a plan and consultation to manage nonnative aquatic species.

Climate change is predicted to affect climate and hydrology in the region, which could affect humpback chub and its critical habitat within the action area. In the arid/semiarid western states, climate change is having serious consequences on the region's scarce water supplies; this particularly applies to the snow that makes up most of the region's precipitation and that, when melted, provides 70% of its water. To date, decreases in snowpack, less snowfall, earlier snowmelt, more winter rain events, increased peak winter flows, and reduced summer flows in rivers have been documented (Saunders et al. 2008).

Warmer climatic and weather conditions may also cause changes to fisheries habitat, shifts in species geographic ranges, increased water demands for instream ecosystems and thermoelectric power production, increased power demands for municipal uses (including cooling), and increased likelihood of invasive species infestations. These effects could substantially change the environmental baseline of the humpback chub; however, no significant impacts are likely to occur during the life of this project.

CONCLUSION

After reviewing the current status of the humpback chub, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is our opinion that the WSFR funding supported proposed triploid rainbow trout stocking at Lees Ferry is not likely to jeopardize the continued existence of humpback chub nor result in adverse modification of its critical habitat. Although a number of individual humpback chub will be displaced or preyed on by harassment of adults or harm of young chub and possibly the take of humpback chub eggs by predation by stocked rainbow trout. Fish community structure disruption is not anticipated to result in population level impacts to the humpback chub in this area for the proposed 2018 and 2019 stocking of triploid rainbow trout. Individual humpback chub will be taken but not to such and estimated level that population level impacts will result. Taking of humpback chub will be a small number compared to the current estimated stable population's level.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly

impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Action Agencies so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(a) (2) to apply. The Action Agencies have a continuing duty to regulate the activity covered by this incidental take statement. If the Action Agency (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(a)(2) may lapse. In order to monitor the impact of incidental take, the Action Agencies must report the progress of the action and its impact on the species to the Service (AESO) as specified in the incidental take statement. [50 CFR §402.14(i) (3)].

AMOUNT OR EXTENT OF TAKE

We anticipate the proposed action is reasonably certain to result in incidental take of humpback chub in the Lower Colorado River Basin population. This incidental take is expected to be in the form of harm (including direct fatality) and harassment resulting from the effects of the proposed action on chub. Incidental take is anticipated to occur from the rainbow trout consuming larval and sub-adult humpback chub, and perhaps eggs. The Service in coordination with GCMRC developed a model to estimate the loss of humpback chub as a result of the proposed action. Estimates of emigration and predation were based on studies of wild rainbow trout in the action area and were provided by modifications of Yard et al. (2015) and Korman et al. (2012 and 2015) formulas in coordination with the Service, GCMRC, and the Department. Modifications to this estimate also included up to date data on rainbow trout and humpback chub numbers provided by GCMRC and the Department. For a full description of the justification and estimation of predation please see Appendix B of this document.

Staff from the Department has developed a model based on stocked rainbow trout from other geographic locations than the action area outside of the Colorado River (Department, pers. comm. 2018). The model focuses on using a daily rate method and includes inputs for movement and predation from studies in other geographic locations. One of the basic premises of the Department’s model is that hatchery raised fish may behave differently than wild-born neighbors. These behavioral differences may include differences in movement and efficacy of initial foraging capability upon stocking. If behavior of hatchery reared rainbow trout is different from wild-born trout than estimated take could be different than stated and possibly as low as 9.9 humpback chub consumed as a result of this action; or an estimated 2 fish per year (Department pers. comm. 2018).

Additionally, the Department staff evaluated the model in Appendix B and concluded this model may overestimate the number of migrants, and consequently the number of humpback chub consumed, due to density of trout stocked during one stocking event. They suggest using a daily rate that takes into account trout loss prior to movement out of the Lees Ferry reach. The model used in Appendix B estimates predation of humpback chub by the annual number of trout stocked (not accounting for batch size of each stocking) at 3-month intervals.

Although it is possible that currently stocked rainbow trout might behave differently than the wild-born rainbow trout population that was last stocked in 1998, we anticipated that environmental conditions tied to the geographic location and density of the current fish population also plays a crucial factor in all trout behavior in the action area. As such, we accept that there is uncertainty in the possible outcome of this stocking, with multiple models being used to inform management decisions. As such, we find that using the existing literature for the action area to create a model of predation and provide inputs to estimate take is justified, but provide a range of estimates of predation which also includes results from the Department model. We estimate take in the form of harm and/or harassment by predation of larval humpback chub to range from 2 – 40 individual humpback chub larvae per year (see Appendix B). We analyzed take of this proposed action using the model in Appendix B, while recognizing the value in other modeling efforts which points to fewer (not more) fish being lost, outlining a more positive range of possible outcomes of the proposed action.

Currently, we do not have a meaningful way to estimate take in the form of harassment of larval humpback chub as a result of rainbow trout attempting to forage on YOY in cold water or other sub-optimal conditions. Resulting may include energy expenditure on young humpback chub that may impact their fitness and survival. Harassment of adult humpback chub is also possible because rainbow trout can be aggressive and territorial while foraging. If harassment in this form happens it may result in competition and a reduction in the ability of adult humpback chub to shelter, forage, or reproduce. The Service anticipates incidental take of humpback chub may be difficult to monitor over the timeframe of this action, for the following reason(s): 1) humpback chub that have been consumed by rainbow trout cannot always be detected; 2) early detection of effects to larval humpback chub that may lead to decreased survival or fitness is not feasible; 3) detection of harassment of adults and loss of opportunities to forage, shelter or breed are limited; 4) the status of the species is changing over time through immigration, emigration, and natural loss; and, 5) the species occurs within almost 300 miles (483 km) of river including the action area in extremely remote locations, so individual humpback chub are difficult to locate.

Because of the challenges of quantifying incidental take, the uses of surrogate measures have been adopted to determine when take has been exceeded. We have estimated the level of anticipated incidental take based on a population viability assessment used by efforts and monitoring of LTEMP, estimates of rainbow trout movement and predation in Appendix B of this document, and the works of the GCMRC and its cooperators (Korman et al. 2012, Avery et al. 2015, Korman et al. 2015, Yard et al. 2015, Young et al. 2015, Ward 2018 in press, Yackulic, 2018). If any of the action triggers are met within 2 years of last stocking triploid rainbow trout then incidental take will have been exceeded. Additionally, if $\geq$ 1.5% (240 individuals) of stocked rainbow trout move down stream of the stocking location in Lees Ferry from any

stocking event, or by annual total (16,000 triploid rainbow trout stocked in 2018 or 2019); then incidental take will have been exceeded. Information gathered by the conservation measures will ensure that monitoring results are sufficient to determine when anticipated take of humpback chub is exceeded.

EFFECT OF THE TAKE

In this BO, the Service determines that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. We reach this conclusion because the anticipated take of individual humpback chub is low relative to the size of the overall population. Additionally, although by definition one of the PCEs are impacted by definition in that it adds nonnative fish to Critical Habitat; we anticipate that so few stocked trout will be added that it will have limited impact to Critical Habitat and not to the level that all PCEs will be impacted. In other words it will not decrease the conditions of Critical habitat to such an extent that it no longer has a conservation benefit to the species.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

We determine that the proposed action incorporates sufficient conservation measures to monitor and minimize the effects of incidental take of humpback chub. Take is estimated to be relatively low when compared to population estimates of adult humpback chub and the stocking action will cease prior to the need of severe intervention to protect humpback chub population level impacts. All reasonable measures to minimize take have been incorporated into the project description. Thus, no additional reasonable and prudent measures are included in this incidental take statement. Annual monitoring reports will be submitted to this office.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the Service's Law Enforcement Office, 2450 W. Broadway Rd, Suite 113, Mesa, Arizona, 85202, telephone: 480/967-7900) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office (AESO). Care must be taken in handling sick or injured animals to ensure effective treatment and care and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

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

1) We recommend an investigate the potential use of dead woody vegetation additions into the Lees Ferry reach to act as fish habitat improvement, and additional allochthonous nutrient input as a cooperative effort between the Department and NPS. The Department's FMP states this is one option to improving the Lees Ferry Fishery.
2) We recommend providing resources to aid GCMRC and partners in ongoing investigations of the food web in the Lees Ferry reach (aquatic invertebrates) and provide a feasibility study of management of native invertebrates (possibly including ephemeroptera, plecopterta, and trichoptera taxon) in coordination with Reclamation, NPS, GCMRC and other partners. The food base in the Lees Ferry reach is important to support the recreational fishery goals. Additionally, humpback chub management could benefit from this activity due to a better understanding of the invertebrate community on which they rely for food.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the Project Description of this Opinion. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, stocking will cease pending reinitiation.

In keeping with our trust responsibilities to American Indian Tribes, we encourage you to continue to coordinate with the Bureau of Indian Affairs in the implementation of this consultation and, by copy of this BO, are notifying the following Tribes of its completion: Zuni, Navajo, Hualapai, Southern Paiute Consortium, and Hopi.

We appreciate the Department's and WSFR's efforts to identify and minimize effects to listed species from this project. Please refer to the consultation number 02EAAZ00-2018-F-0234, in future correspondence concerning this project. If you note errors or need clarification of information in this final opinion, please call Jessica Gwinn at (602) 242-0210 or email jessica_gwinn@fws.gov.

Sincerely,

/s/ Debra Bills
Acting Field Supervisor

cc:
Chief, Adaptive Management Group, Bureau of Reclamation, Upper Colorado Region, (Electronic copy)

Bureau of Reclamation, Upper Colorado Region, (Attn: Lee Traynham and Marianne Crawford) (electronic copy)

Superintendent, Glen Canyon National Recreation Area, Glen Canyon National Recreation Area, (Attn: Rob Billerbeck) (Electronic copy)

Grand Canyon National Park Superintendent, Grand Canyon National Park, (Attn: Rob Billerbeck) (electronic copy)

Chief, U.S. Geological Survey, Grand Canyon Monitoring and Research Center (electronic copy)

Bureau of Indian Affairs-Western Regional Office Mailroom Phoenix, (Attn: Chip Lewis)

Chairman, the Hopi Tribe
Wildlife & Ecosystems Management Program (Attn: Darren Talayumptewa)
Hopi Cultural Preservation Office (Attn: Stewart Koyiyumptewa and Terry Morgart)
Tribal Chairman, Hualapai Tribe
Kerry Christensen, Hualapai Department of Cultural Resources, Historic Preservation Office
Annette Bravo, Hualapai Tribe
Hualapai Department of Anthropology (Attn: Dawn Hubbs)

Chairwoman, Kaibab Band of Paiute Indians
Director, Southern Paiute Consortium
Wildlife Program Manager, Tribal Affairs Building
Chairperson, Las Vegas Tribe of Paiute Indians

Chairman, Moapa Band of Paiute Indians
President, Navajo Nation,
Melinda Arviso-Ciocco, Navajo Nation
Navajo Nation, Tribal Historic Preservation Officer, (Attn: Richard Begay)
Kim Yazzi, Navajo Nation

Chairwoman, Paiute Indian Tribe of Utah
President, San Juan Southern Paiute Tribe

Chairman, Ute Mountain Ute,
Terry Knight, Sr., Tribal Historic Preservation Officer, (Attn: Terry Knight Sr.)
Contract Administrator, (Attn: Nichol Shurack)

Chairwoman, Yavapai-Apache Nation,
Yavapai-Apache Nation (Attn: Chris Code)
Yavapai-Apache Nation, (Attn: Gertrude Smith)

Yavapai-Apache Nation (Attn: Vincent Randall)

Governor, Pueblo of Zuni

Director & Tribal Historic Preservation Officer, Arizona

Arizona Game and Fish Department, Deputy Director, Jim deVos

cc (electronic copy):

Office of Assistant Secretary for Water and Science (Attn: Sarah Rinkevich)

Project Leader, Arizona Fish and Wildlife Conservation Office, Flagstaff AZ

Wildlife and Sport Fish Restoration (Attn: Nicole Jimenez)

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APPENDIX A: CONCURRENCES

This appendix contains our concurrences with your "may affect, not likely to adversely affect" determinations for the southwestern willow flycatcher *(Empidonax traillii extimus)*, California condor (*Gymnogyps californianus*), and razorback sucker (*Xyrauchen texanus*). Additionally, you have determined this action will not adversely modify associated critical habitat. Conservation measures were not proposed for the before mentioned species and determinations.

Southwestern willow flycatcher

The historical range of the southwestern willow flycatcher included southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico. The current range is similar to its historical range, but the quantity of suitable habitat within that range has been greatly reduced. The Service (2002) estimate that the total range wide population to be 1,200 – 1,300 territories/pairs.

In Arizona, historically this species was found along portion of rivers within all the major watersheds. 328 territories were documented in 2000 on 12 drainages (Bill Williams, Big Sandy, Colorado, Gila, Hassayampa, Little Colorado, Salt, San Francisco, San Pedro, Santa Maria, and Verde Rivers and Tonto Creek). In 2002, flycatchers were also documented on the Virgin River and Cienega Creek, a tributary of the Santa Cruz River. Southwestern Willow Flycatcher has been recorded in the Grand Canyon. The nearest observation is 1 mi (1.6 km) downstream of the stocking site.

Petitioned for listing in 1992, and in 1993 FWS published a proposal to list as Endangered with critical habitat. The Final Rule was published in 1995, but deferred designation of critical habitat. Under a court order in 1997, critical habitat was designated. However, a 2001 10th circuit court of appeals decision set aside the designated critical habitat within the court's jurisdiction. In response to the lawsuit, the Service decided to set aside critical habitat throughout the subspecies range. It was revised again in 2013.

The cause for the species decline is primarily loss, degradation, and fragmentation of riparian habitat within the subspecies range caused by dams, water diversions, groundwater withdrawal, channelization, phreatophyte control, livestock grazing, recreation, fire, urbanization, agriculture development; introduction of invasive exotic plant species [e.g., tamarisk (*Tamarix spp*.), Russian olive (*Eleagnus angustifolia*), and giant reed (*Arundo donax*)]; brood parasitism; demographic and genetic effects of small population size; and migration and winter range stresses.

The proposed action is designed to increase angler use in the Lees Ferry area. If this occurs, additional human presence is anticipated in the area and could result in minimal alterations of foraging or nesting behavior. However, flycatchers are very rare along the Colorado River above RM 75, and adverse are extremely unlikely to occur. Any disturbance is anticipated to be discountable. We concur that the action may affect, but will not adversely affect the southwestern willow flycatcher.

California Condor

Historically the California condor was found throughout the west. In Arizona, there were a few sight records in the 1880s, from southeast to northwest. Prior to reintroduction the latest recorded observation was October 3, 1924, when one was seen north of Williams. They were reintroduced to Vermillion Cliffs (December 1996), and Hurricane Cliffs (1998), Arizona. California condor has been documented along the Grand Canyon in the vicinity of the proposed project area.

Listed as endangered in 1967, the Arizona population was listed as a 10(j) Non-essential, Experimental Population in 1996. Approximately 10,000 years ago, the Pleistocene extinction wiped out many large mammals that condors relied on for food. This loss of large prey naturally reduced their range to the Pacific Coast between British Columbia and California, however recent decline in populations were human induced (e.g. poisoning, intentional shootings, habitat destruction, and egg collection).
California condors inhabit the Upper Sonoran life zone at 1,518 - 4,521 ft. in elevation. Nests are situated either at some distance above bottoms of cliffs or on steep slopes presumably providing air space for birds to approach and leave nests. There is suitable habitat for California condor in areas adjacent to the project area where cliffs and steep slopes exist.

The proposed action is designed to increase angler use in the Lees Ferry area. If this occurs, additional human presence is anticipated in the area and could result in minimal alterations of foraging or nesting behavior. Any disturbance is anticipated to be insignificant and discountable due to the short duration of the action that the current recreational use level in the area. We concur that the action will not jeopardize the continued existence of the California condor.

Razorback Sucker and its Critical Habitat
The razorback sucker is endemic to the Colorado River Basin and formerly occurred in all major rivers and larger streams in the Basin and was once the most widespread and abundant of the Basin's big-river fishes. In the Lower Basin, populations are isolated to Lakes Mohave, Mead, and the lower Colorado below Lake Havasu. In the Upper Basin, small remnant populations are found in the Green, Yampa and mainstem Colorado Rivers. These suckers are also found in the San Juan River near the new Mexico-Utah border.

In the lower basin, the largest extant population occurs in Lake Mohave, while small numbers of individuals occur in Lake Mead and in the Grand Canyon. Razorback sucker have been reintroduced into several locations in the lower basin. More than 12 million young and juveniles were stocked into riverine habitats in Arizona and California from 1981-1990, but indications are that nonnative predatory fishes consumed most of these stocked fish. In 1991, the Department and its cooperators increased the size of the stocked fish to approximately 30 cm. Since 1994, 13,250 suckers have been stocked into the Verde River near Childs Power Plant, and 2046 were stocked into the Salt River at Horseshoe Bend upstream of Roosevelt Lake. The reintroduced populations in both rivers are fully protected under the Endangered Species Act.

Razorback sucker were historically recorded (1978) about 1 mi (1.6 km) downstream of the stocking area. The nearest known occurrence of razorback sucker is 60 mi (97 km) downstream

of Lees Ferry near the confluence of the Little Colorado River. Critical Habitat for razorback sucker still exists 1 mi (1.6 km) downstream of the project area.

Habitat preferences change seasonally, with water type, and life stage. Within rivers during spring, adults prefer runs and backwaters; during summer the fish can be found over mid-channel bars, in runs and pools; and during winter deeper water seems to be preferred including runs, slack-water, eddies, and pools. In impoundments, this species utilizes both backwater and the main impoundment. Juveniles in reservoirs use near-shore habitats but disperse within a few weeks. Juvenile habitat selection within rivers has not been well studied. Young razorbacks presumably require quiet, warm, shallow water as nursery habitats in rivers, and backwaters in can provide quiet water where there is the potential for increased food availability. In reservoirs, coves can provide warm, shallow shorelines suitable as nursery habitat. There is limited habitat for Razorback Sucker within the project area due to the altered flow regimes and thermocline resulting in lower temperatures. Razorback sucker do not thrive in low temperature waters.

Spawning has been documented in mainstem rivers, riverine-influenced areas of large impoundments, and wave-washed shorelines of reservoirs. In lacustrine habitats (Lake Mohave), spawning occurs early in the year (January-April/May) in flat or gently sloping shoreline areas over gravel, cobble, or mixed substrates. Water temperatures during spawning may range from 11.5-18^{o}C. In riverine habitats, staging occurs in flooded lowlands and eddies formed in tributary streams, and then the fish move to main-channel sand, gravel, and cobble bars for egg deposition.

We concur that the action may affect, but will not adversely affect the razorback sucker. The justification for our determination is;

1) Although razorback suckers have been detected in the mainstem of the Colorado River, their numbers are relatively low when compared to other native fish species near the confluence of the LCR. This small number of individuals decreases the likelihood that stocked rainbow trout and razorback suckers will come into contact.

2) Razorback suckers spawning has been detected only below Lava Falls so larvae are not likely to be in the action area, nor preyed on by stocked rainbow trout.

3) Stocking will occur outside of the anticipated spawning season of razorback suckers, therefor there will be a negligible chance of trout interfering with spawning behaviors if it exists.

4) Stocking of nonnative rainbow trout inherently impact one of the Primary Constituent Elements (PCEs) outlined as critical habitat for razorback suckers; biological environment. Under the factors listed for the biological environment, areas that are nonnative fish-free are required. The additions of nonnative rainbow trout are expected to impact this PCE and critical habitat, consistent with the analysis provided above. However, given the low number of trout proposed to be stocked in 2018 and 2019 and current nonnative fish assemblage that are present in the area, we anticipate that proposed stocking of rainbow trout will not appreciably diminish the conservation value of critical habitat for razorback sucker under current environmental conditions.

APPENDIX B: DESCRIPTION OF ESTIMATED RAINBOW TROUT MOVEMENT AND PREDATION OF HUMPBACK CHUB

To estimate anticipated take of humpback chub by stocked triploid rainbow trout we coordinated with the U.S. Geological Survey, Grand Canyon Monitoring and Research Center to formulate a simple model. The model assumed a quarterly (three-month) time step and was run over two years (because ~99% of stocked rainbow trout are expected to die within two years based on the Department's prediction of survival). In each time step, the model keeps track of the number of rainbow trout in the Lees Ferry reach, $N_t^{RBT,LF}$, the number of rainbow trout in the 30-mile aggregation, $N_t^{RBT,30}$, the number of rainbow trout in the Little Colorado River (LCR) aggregation, $N_t^{RBT,LCR}$, the cumulative number of juvenile humpback chub eaten in the 30-mile aggregation, $N_t^{HBC,30}$, and the cumulative number of juvenile humpback chub eaten in the LCR aggregation, $N_t^{HBC,LCR}$. In the first time step (i.e., at t=0), all of these values are set equal to zero except $N_t^{RBT,LF}$, which is determined by the number of stocked rainbow trout. In subsequent time steps, values are updated according to the following equations:

$$N_{t+1}^{RBT,LF} = N_t^{RBT,LF}(1 - \phi_{30} - \phi_{LCR})\varphi$$
$$N_{t+1}^{RBT,30} = (N_t^{RBT,LF}\phi_{30} + N_t^{RBT,30})\varphi$$
$$N_{t+1}^{RBT,LCR} = (N_t^{RBT,LF}\phi_{LCR} + N_t^{RBT,LCR})\varphi$$
$$N_{t+1}^{HBC,30} = N_t^{HBC,30} + N_t^{RBT,30}\rho_{30}$$
$$N_{t+1}^{HBC,LCR} = N_t^{HBC,LCR} + N_t^{RBT,LCR}\rho_{LCR}$$

Where ϕ_{30} is the three-month movement rate of rainbow trout from Lees Ferry to 30-mile, ϕ_{LCR} is the three-month movement rate of rainbow trout from Lees Ferry to the LCR aggregation, φ is the three-month survival rate of stocked rainbow trout, ρ_{30} is the number of juvenile chub eaten per rainbow trout in the 30-mile aggregation, and ρ_{LCR} is the number of juvenile chub eaten per rainbow trout in the LCR aggregation. Take at either 30-mile or the LCR aggregation was given by $N_8^{HBC,30}$ and $N_8^{HBC,LCR}$ respectively. Interestingly, we found that take at 30-mile was generally lower even though the expected number of rainbow trout there was greater because there are many fewer juvenile humpback chub at 30-mile (i.e., even though $\phi_{30} > \phi_{LCR}$, $\rho_{LCR} \gg \rho_{30}$). We considered low- and high-end values for each parameter when calculating to give a range of possible outcomes; however, high end values were used for the immigration rate, the intermediate value was used for predation, and the low end value was used for immigration rate in the final reporting in this Biological Opinion in order to analyze the most impactful scenario to make a determination of take and jeopardy, which is necessary to the section 7 consultation. For more information, on parameters and associated derivation, see the Table 1 below.

Table 1. Calculations used for Rainbow Trout (RBT) Distribution Model. Parameters for spreadsheet model

Stocked	Lower end estimates	Higher end estimates	Value for calculation
3-month survival (φ)	Department's estimate (~0.02 annual time scale – 0.38 on 3-month scale)	Korman 2016 (~0.55 annual time scale – 0.85 on 3-month time scale)	We used 0.05 on an annual time scale (0.48 on a 3-month scale) as likely high end value (0.02 is plausible, but potentially too low as many of the studies being cited were not dealing with movement out of the study reach. Did not use higher end estimate based on naturally reproducing trout in the system, as we agree with Department's general argument that survival will be lower for stocked fish.)
3-month movement to LCR (ϕ_{LCR})	Emigration rate (Korman 2015)	Emigration rate (Korman 2015)	Emigration rate (Korman 2015)
3-month per capita effect of rainbow trout on juvenile chub at LCR (ρ_{LCR})	Predation rate (Yard 2011)	Modification to Yard 2011 assuming juvenile chub densities are ~ 4x higher now.	Modification to Yard 2011 assuming chub densities are ~ 4x higher now.
3-month movement to 30 mile (ϕ_{30})	Emigration rate (mean estimate from Korman 2015)	Emigration rate (mean estimate from Korman 2015)	Emigration rate (Mean estimated from Korman 2015)
3-month per capita effect of rainbow trout on juvenile chub at 30-mile (ρ_{30})	(rate modified from LCR, based on ratio of chub abundance at 30-mile to LCR – see below)	(rate modified from LCR, based on ratio of chub abundance at 30-mile to LCR – see below)	Multiply ρ_{LCR} by ratio of chub abundance at 30-mile to LCR.
Ratio of Chub abundance at 30-mile to LCR	Expert opinion	See email chain and explanation to the right.	Expert opinion. Calculated relative catch rates for two aggregations and relative spatial extents, and used to estimate ratio of abundances between aggregations.

Stocked	Lower end estimates	Higher end estimates	Value for calculation

Table 2. Summary of Quantities used in calculation.

RBT stocked	User inputs. 16,000 stocked rainbow trout.
RBT at Lees Ferry	Updates RBT remaining at Lees Ferry after each quarter based on survival and movement rates.
RBT at LCR	Updates RBT that move to and survive at LCR after each quarter based on survival and movement rates.
LCR chub eaten	Running sum of chub in the LCR calculated to have been consumed by stocked RBT. Rounded number in larger font to the left (closer to parameters) is the total consumed over 2 years.
RBT at 30-miles	Updates RBT that move to and survive at 30-mile after each quarter based on survival and movement rates.
30-mile chub eaten	Running sum of chub at 30-mile aggregation calculated to have been consumed by stocked RBT. Rounded number in larger font to the left (closer to parameters) is the total consumed over 2 years.
Total chub eaten per year	Sum of total chub consumed at 30-mile and LCR.