

2.0 Description of Alternatives

This chapter describes and compares alternatives considered for non-native fish control in the Colorado River downstream from Glen Canyon Dam. It includes a description of each alternative considered. This section also presents the alternatives in comparative form, defining the differences between alternatives and providing a basis for choice among options by the responsible official and the public. The information is based upon the environmental, social, and economic effects of implementing each alternative.

Both the no action and proposed action alternatives have common elements with regard to ongoing dam operations for the 10-year period of the proposed action, 2011-2020. Under both alternatives, dam operations would continue in accordance with existing RODs including MLFF, with steady flow releases in September and October through 2012. After 2012, MLFF flows as defined under the 1996 ROD (Bureau of Reclamation 1996) would remain in effect. HFEs may also occur as defined in the High Flow Experiment Protocol Environmental Assessment, if implemented (Bureau of Reclamation 2011). Reclamation and NPS are also beginning a separate NEPA process to develop the LTEMP EIS (76 FR 39435-46, July 6, 2011). A number of elements of the GDCAMP, including dam operations, will be fully reviewed and evaluated and accordingly may change when the LTEMP EIS process is completed.

2.1 *No Action Alternative*

The no action alternative is defined as the current operation for Glen Canyon Dam as approved and authorized under the 2007 Colorado River Interim Guidelines and 1996 and 2007 RODs. Under the current operations, water is released from the dam under the MLFF alternative. In recent consultations on the effects of Glen Canyon Dam operations on endangered fishes and critical habitat, Reclamation and the USFWS have agreed to reduce the numbers of non-native fish that compete with and prey on the endangered fish as conservation measures. These agreed upon conservation measures occur in the 2007 Colorado River Interim Guidelines Opinion and the 2008 Opinion, the 2009 Supplement, and the 2010 biological opinion on cancelling the 2010 non-native fish control removal trips (U.S. Fish and Wildlife Service 2007, 2008, 2009, and 2010). This EA is in large part driven by commitments and responsibilities to maintain compliance with the ESA. The need for non-native fish control arose out of ESA Section 7 consultations on dam operations, and implementation of non-native fish control through the GCDAMP by physical removal. This EA is in large part driven by commitments and responsibilities to maintain compliance with the ESA. The need for non-native fish control arose out of an ESA Section 7 consultation on dam operations, and implementation of non-native fish control through the GCDAMP by physical removal is part of the proposed action for the operating biological opinion on Glen Canyon Dam operations, the 2011 Opinion (U.S. Fish and Wildlife Service 2011).

The no action alternative consists of no implementation of any form of non-native fish control other than the NPS project to remove non-native rainbow and brown trout from

Bright Angel Creek (RM 88) because this project is ongoing, is a separate project being implemented by another DOI agency (NPS), and has existing NEPA compliance (National Park Service 2006b), as well as separate, and complete government-to-government tribal consultation. The NPS Bright Angel Creek Project would be ongoing and can thus be considered as part of every alternative for the purposes of evaluating cumulative effects. NPS is also removing trout in Shinumo Creek as part of efforts to translocate humpback chub from the LCR to Shinumo Creek and the USFWS also translocates humpback chub periodically from the lowermost mile of the LCR to above Chute Falls in the LCR; both of these actions would also continue under no action, and are covered by existing NEPA and have completed tribal consultation. No further efforts to reduce non-native fishes, rainbow trout, rainbow trout migration, or otherwise directly enhance humpback chub populations are undertaken. The intent of this action is to provide a default for comparison of the effects of the proposed action.

2.2 Proposed Action

The proposed action is a 10-year effort to conduct research, monitoring and actions to evaluate methods of removal of non-native fish as a means to improve conditions for native fish, in particular the humpback chub along with monitoring efforts to track movement and numbers of non-native fish within the river system. The proposed action is also intended to address the concerns of some tribes regarding the taking of life associated with non-native fish control in a sacred location, the Grand Canyon. This alternative would be implemented with continued MLFF dam operations in accordance with the 1996 and 2007 RODs. The 10-year period of the action is appropriate to coincide with the potential implementation of the HFE Protocol EA, also a 10-year action, because there is evidence, discussed in other sections, that HFEs may benefit rainbow trout. The 10-year timeframe is also necessary to ensure a long-term commitment to implementing the conservation measure, and to provide a reasonable experimental timeframe to evaluate non-native fish control through research and monitoring in an adaptive management context.

The proposed action utilizes a strategy of research on the effects of non-native fish predation on humpback chub recruitment and investigation of the sources of rainbow trout in the LCR reach to determine the need for continued nonnative fish removal and the most cost-effective location of removal (i.e. the PBR or LCR reach). The proposed action would evaluate the potential to remove non-native rainbow trout in the PBR reach (RM 1 to RM 8) using boat-mounted electrofishing. Two removal trips would be conducted in the first year of the proposed action to help evaluate the extent to which rainbow trout emigrate from Lees Ferry and the effectiveness of removal to reduce this emigration. Up to 10 PBR reach removal trips could be conducted in any one year for the ten-year period of 2011-2020, but the number of removal trips would depend on the outcome of research efforts to evaluate the extent to which predation limits humpback chub, and the efficacy of PBR removal at reducing rainbow trout abundance in the LCR reach. The proposed action also includes monitoring of humpback chub status, both numbers of adult and juvenile humpback chub, and potential removal of non-native fish in the LCR reach (RM 56-66). Removal of non-native fish in the LCR reach would only take place if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 Opinion (U.S. Fish and Wildlife

Service 2011). The proposed action would also include continuing research to refine triggers for juvenile humpback chub abundance and survivorship to consider in implementing LCR reach removal. This research would also help determine the overall importance of mainstem habitats to humpback chub recruitment.

The proposed action may result in thousands of fish being removed from the system per year. Prior efforts from 2003-2006 (four years of removal) resulted in 23,266 non-native fish removed. To address the tribal concerns on the disposition of removed fish, non-native fish would be removed live and stocked into areas that have an approved stocking plan, unless, and only unless, live removal fails, then fish would be euthanized and used for later beneficial use (such as, used for human consumption, or for feeding eagles, other raptors, or other captive wildlife, particularly those animals kept and reared by tribes). Other uses for removed fish may be identified over the 10-year period in consultation with appropriate parties including American Indian tribes.

Removal of rainbow and brown trout from Bright Angel Creek with a fish weir in fall of 2002 and 2006 has been shown to be an effective means of non-native fish control for both rainbow and brown trout (Leibfried et al. 2003, 2006). NPS removed from Bright Angel Creek 525 brown trout from 2006-2007, and 454 rainbow trout and 594 brown trout from 2010-2011 using a combination of a fish weir trap and electrofishing. The NPS Bright Angel Creek removal project is ongoing and is expected to continue to be effective at reducing brown trout in what is considered to be the primary source of brown trout to the LCR reach. Reclamation has committed to working with the NPS to continue to fund and expand this effort as a conservation measure of the 2011 Opinion. The NPS will also be conducting removal in Shinumo Creek as part of a project to translocate humpback chub from the LCR to that stream. NPS removed 1,220 rainbow trout and one brown trout were removed from Shinumo in 2009, and 929 rainbow trout in 2010. Both of these actions have existing compliance including NEPA and completed tribal consultation. The cumulative effects of these actions are analyzed here, along with related effects of humpback chub translocations.

Methods for non-native fish control would be similar to removal conducted from 2004-2006 and in 2009 (Coggins 2008a; Coggins and Yard 2010). The method of removal in the PBR and LCR reaches would be to use boat-mounted electrofishing as described in Coggins et al. (2011) to remove all non-native fish captured. Motorized electrofishing boats would operate at night, utilizing gas-generators to power lights and electrofishing equipment. For PBR reach removal, each trip is anticipated to take place over up to 12 nights. Researchers would be land-based with no riverside camping, and boats would launch for nightly work late in the day, after all recreational trips have launched and traveled downstream. The work would take place between the Paria River and Badger Rapids only. Boats would return to Lees Ferry at the conclusion of their nightly work. Care would be taken to avoid disturbance to walk-in recreationists and anglers at the Paria River confluence beach, although some disturbance to recreationists would be likely to occur due to the presence of fish tanks located near shore or net pens in the river to hold fish that are removed, and the need for multiple nights of electrofishing required for removal. For LCR reach removal trips, duration would

likely be several weeks, with removal teams camped and working in the LCR reach for approximately two weeks.

Removal in the PBR reach is predicted to be of primarily juvenile rainbow trout before they descend downstream to the LCR reach, but all non-native fish captured would be removed. PBR reach removal would be done in fall or winter (during expected emigration periods), or via multiple trips throughout the year if necessary. Boats can travel as far downstream as Badger Creek Rapid (RM 8) and return upstream to Lees Ferry without camping, therefore avoiding the costs associated with downriver travel and minimizing impacts to wilderness experience and values through the entire Grand Canyon.

During the first two years of the proposed action, the action would include one rainbow trout marking trip in the Lees Ferry reach (RM -15 to 0) in the fall of each year. This trip would utilize PIT tags to mark individual rainbow trout to detect their downstream movement. Initially, two PBR reach removal trips would be conducted in the fall and winter months to test the efficacy of PBR reach removal in reducing downstream emigration of rainbow trout from Lees Ferry. Depending on the results of the two initial PBR reach removal trips, additional trips could be added. Also, three to four downstream monitoring trips would be conducted in summer 2012 to detect downstream movement of rainbow trout and conduct nearshore ecology work on juvenile humpback chub to better track trends in juvenile humpback chub abundance. Monitoring would be modified based on results from these trips and other monitoring through adaptive management in future years.

Monitoring is needed to determine whether the action is meeting the purpose and need. Monitoring of mainstem fishes would be conducted by using non-lethal electrofishing periodically in Glen, Marble and Grand canyons. Monitoring may be modified through adaptive management over the life of the proposed action. Removal would be conducted based on monitoring information. Removal actions would continue to be evaluated and refined to meet management objectives, including the viability of the Lees Ferry trout fishery and recovery of the Grand Canyon population of humpback chub. If unsuccessful, these actions would need to be reevaluated and refined as necessary to achieve the management objectives, and additional actions may need to be considered. In 2014 Reclamation would undertake a scientific review through a workshop with scientists and managers to assess what has been learned from the first two years of non-native fish control. This will be the first of multiple reviews of this proposed action to occur periodically over the life of the proposed action.

As described earlier, Reclamation and the NPS are currently engaged in the development of the LTEMP and the LTEMP EIS. The purpose of the proposed LTEMP is to utilize current, and develop additional, scientific information to better inform Departmental decisions and to operate the dam in such a manner as to improve and protect important downstream resources while maintaining compliance with relevant laws including the GCPA, the Law of the River, and the ESA. Information developed through this EA and through the monitoring and implementation of the proposed action will be further reviewed and analyzed as part of the LTEMP process. That is, while this EA is designed to analyze and adopt an approach to non-native fish control, the effectiveness of such actions will also be further analyzed, integrated

and potentially refined and/or modified as part of the LTEMP NEPA process. Scientific and resource information developed through this EA, and the implementation of the non-native fish control efforts of the proposed action are essential to ensuring that fully informed decisions are made as part of the LTEMP process.

2.2.1 *Other Flow and Non-Flow Actions*

Reclamation would also, as part of the proposed action, begin a two-year process with stakeholder involvement to develop other non-native fish control options to reduce recruitment of non-native fish at, and emigration of those fish from, Lees Ferry. Both flow and non-flow experiments focused on the Lees Ferry reach may be conducted in order to experiment on actions that would reduce the recruitment of trout in Lees Ferry, and likely thereby reduce emigration of trout from Lees Ferry. These actions may also serve to improve conditions of the recreational trout fishery at Lees Ferry. Additional environmental compliance may be necessary for these experiments. Although alternatives utilizing Glen Canyon Dam flows to reduce recruitment and emigration rates of trout in Lees Ferry did not perform well in the SDM Project, there is evidence that flows may be a more economical and effective long-term method of mitigating the effects of trout on humpback chub (Korman et al. 2005, Runge et al. 2011). However, developing flows and other actions that are likely to be effective in reducing rainbow trout may present significant impacts to other resources. And flow options alone also may prove to be ineffective at reducing emigration of trout from the Lees Ferry population. Thus the goal is to use adaptive management to experiment with a variety of options to develop a long-term management strategy that is culturally sensitive and cost effective.

In evaluating flow options for use in non-native fish control, Reclamation would evaluate a number of research elements, including, but not limited to, the following:

- Determining if stranding flows could reduce rainbow trout recruitment by de-watering redds or stranding juvenile trout;
- Evaluating the potential for utilizing changes in down-ramp rates to strand or displace juvenile trout and reduce recruitment;
- Evaluating different types and magnitudes of stranding flows;
- Evaluating the potential to use water quality of dam releases (low oxygen levels) below Glen Canyon Dam to reduce trout survivorship.
- Determining if flow and non-flow actions in Lees Ferry are effective in improving the Lees Ferry trout fishery.

Developing and testing dam releases and other non-flow methods would require involvement of both scientists and stakeholders to adequately analyze effects of these actions. Reclamation would work with these groups to develop a proposal and science plan for

implementing and evaluating these flow and non-flow actions with these groups over the next one to two years.

2.3 Mitigation and Monitoring

Mitigation measures are prescribed to avoid, reduce, or compensate for potential adverse effects of an action. Earlier implementation of elements similar to those in the proposed action were initiated in 2002-2003 as an experiment to test the benefits of non-native fish control to native fish in Grand Canyon. Later beginning in 2008, such actions were included as conservation measures of a USFWS biological opinion. The proposed action has also now been considered by USFWS and a new biological opinion on the proposed action, along with the implementation of the HFE Protocol and the MLFF, is attached as Appendix E (U.S. Fish and Wildlife Service 2011). This new biological opinion includes a number of conservation measures that are related to the proposed action in terms of mitigation. These include: Re-evaluation points, or periodic reviews with the USFWS and other stakeholders to evaluate the effectiveness of the proposed action; Humpback Chub Nearshore Ecology Study, through the Natal Origins Study, Reclamation will, through the GCDAMP, continue research efforts on nearshore habitat use of young humpback chub in the LCR reach; Humpback Chub Refuge, Reclamation will continue to assist FWS in maintenance of a humpback chub refuge population at a federal hatchery; Humpback Chub Monitoring and Mainstem Aggregation Monitoring, Reclamation will, through the GCDAMP, continue to conduct annual monitoring of humpback chub including the eight mainstem aggregations of humpback chub in Marble and Grand Canyon annually and conducting the ASMR on a 3-year schedule; Bright Angel Creek Brown Trout Control, Reclamation will continue to fund efforts of the NPS to remove brown trout from Bright Angel Creek and will work with GCMRC and NPS to expand this effort to be more effective at controlling brown trout in Grand Canyon; High Flow Experiment Assessments, Reclamation will conduct pre- and post-HFE assessments of existing data on humpback chub status and other factors to both determine if a HFE should be conducted and to inform decisions to conduct future HFEs; Dexter National Fish Hatchery Genetic Study, Reclamation will fund an investigation of the genetic structure of the humpback chub refuge housed at the Dexter National Fish Hatchery and Technology Center; Kanab ambersnail (*Oxyloma kanabensis haydenii*), Reclamation will continue, through the GCDAMP, to monitor the population on a periodic basis to assess the health of the population over the life of the proposed action; Conservation of Mainstem Aggregations, Reclamation will also, as part of its proposed action, work within its authority through the GCDAMP to ensure that a stable or upward trend of humpback chub mainstem aggregations can be achieved.

The following additional mitigation measures would be implemented if the proposed action is selected.

- An interpretive plan would be developed with NPS to develop public information and educational materials describing project effects.

- Crews working in the park units would be required to meet minimum impact requirements, including evaluations and approval, for all work within proposed wilderness areas.
- Fish removed would either be kept alive and stocked into other waters as sport fish or would be euthanized for later beneficial use identified through continued tribal consultation. Stocking into other waters would require an existing stocking plan for the water.
- Resolution of adverse effects to historic properties (traditional cultural properties) would be completed in accordance with Section 106 of NHPA.

Monitoring would be an important aspect of this action, once implemented. Monitoring should be conducted in a manner that evaluates, as much as possible, the effects of removal in both reaches, and to provide information on key hypotheses and additional scientific information regarding information on non-native fish in the Colorado River below Glen Canyon Dam as well as the effectiveness of actions addressing non-native fish control. Every effort will be made to ascertain the degree of effect attributed to each treatment. This is necessary in order to determine if removal in either or both the reaches are having positive, little or no effect and should be continued, modified or eliminated. Monitoring data for both trout and humpback chub abundance would be used to determine when removal would take place. A science plan was developed to better define monitoring and research associated with the proposed action, and is included in Appendix B.

2.4 *Alternatives Considered and Eliminated from Detailed Study*

In addition to the proposed action, Reclamation also evaluated and eliminated the following alternatives from detailed study.

Humpback Chub Head-start Option

This action proposed adding a supplemental hatchery-based stocking program to maintain the desired population level for the humpback chub in lieu of control methods currently in place. Wild-caught humpback chub would be grown in hatcheries and stocked into the system. This option does not address or meet the purpose and need since it does not reduce predation and competition from non-native fish on humpback chub. This action would have to be initiated and implemented under the authority of the USFWS, and would likely take time to implement, potentially delaying needed efforts to address the purpose and need for the action. For these reasons, this option was eliminated from further consideration.

Removal of Trout by Anglers

This action proposed changing fishing regulations and restrictions to allow a greater take of rainbow trout and brown trout by anglers as a way to reduce the trout populations. The primary reason this action was not analyzed here is that it is not within the authority of Reclamation to implement. Fishing regulations in the state of Arizona are the purview of the

Arizona Game and Fish Commission and AZGFD, as well as the NPS, which has authorities and responsibilities for fisheries management within GCNP and GCNRA. Although there is much uncertainty about the efficacy of this action to remove non-native fish from the system, more aggressive harvest regulations could have the potential to help remove trout from the system, and should be further considered by AZGFD and NPS. It is Reclamation's understanding that NPS intends to address this issue in fisheries management plans for GCNP and GCNRA.

This action also contains a great deal of uncertainty as to whether the fishing public would keep and kill the fish they catch, or if most anglers would continue to practice catch-and-release angling. Also, the fish that are typically caught by anglers in Lees Ferry are older fish that are not believed to be the primary migrants to downstream areas occupied by native fish, thus angling would have little effect on the age-0 fish that use shallow nearshore habitats and are thought to be the principal downstream emigrants. Another uncertainty is the effect of a density-dependent response to reduced numbers of adult trout, whereby the fewer eggs and young produced would have more space and resources and expected higher survival and growth rates.

Use of Barrier Devices to Kill Fish or Impede Their Movement

A variety of barrier devices are in use or in experimental stages that can kill fish (shock wave) or impede their movement (e.g., electric fences, sound, flashing lights, bubble curtains). These strategies were not selected for detailed analysis in the EA process for several reasons. Many of these methods and techniques are experimental and untested, thus their effectiveness in Grand Canyon is highly uncertain. These actions pose potential public safety risks, especially in a place that receives high levels of recreational boating use such as Grand Canyon. A barrier to prevent downstream movement of rainbow trout from Glen Canyon would need to be constructed in Marble Canyon, likely downstream of the Paria Riffle. A barrier of the scale needed in Marble Canyon could pose a public safety hazard because it could harm boaters that routinely navigate through the area. Placing a barrier to impede downstream movement of trout could also indiscriminately affect and injure non-target native fish, especially native flannelmouth suckers. Also, a barrier of the size needed to reduce or eliminate emigration of trout from Lees Ferry in a large river like the Colorado River would be a large construction effort, which would likely degrade the wilderness values for which GCNRA and GCNP were created. For these reasons, such an action is not likely within the scope of an EA, and was not analyzed further in this NEPA process.

Stocking of Triploid Trout

The AZGFD uses triploid trout of various species to stock waters in Arizona for sport fishing. Triploid trout are produced in hatcheries to have three sets of chromosomes (as opposed to the normal two). Triploid trout are similar to normal trout in every respect except that they are sterile and grow faster and larger. Triploid trout therefore present less of a risk in terms of negative impacts of a non-native fish to an ecosystem than normal trout because they do not reproduce. They are also favored by many anglers because they grow quickly and to a larger size than normal trout.

This action was included in several alternatives of the SDM Project. Stocking of triploid trout at Lees Ferry was proposed to be implemented to offset reductions in the trout population from removal or other actions. Triploid trout would not reproduce and thus not add additional spawning trout to the Lees Ferry population, and the addition of stocked triploid trout would help to meet the objectives of the angling community in Lees Ferry by both improving catch rate and mean size of fish caught because triploid trout grow faster and larger than non-triploid trout. However, Reclamation has no authority to stock fish or manage fish populations. Stocking fish in Lees Ferry is an action that falls under the authority and responsibility of the AZGFD and NPS and must be initiated by those agencies. This action was proposed to mitigate losses in fishing quality in GCNRA. The proposed action does not include removal of trout from the GCNRA and is not anticipated to result in year-class losses or severe reductions in fishing opportunity or quality. For these reasons, this action was not considered further. Notably, fishing guides and recreational anglers consulted in this EA process were in support of this action, thus AZGFD should further investigate implementing a stocking program.

Removal of trout 1.5 miles upstream of the LCR

Although this strategy was proposed during the SDM Project, it was not selected for inclusion in any of the alternatives by the cooperating agencies and tribes. This was primarily because: it was deemed less effective at reducing predation losses of humpback chub because a much greater proportion of predation occurs downstream from the LCR than upstream (Yard et al. 2011); it would not address the issue of competition effects between rainbow trout and humpback chub because a greater proportion of humpback chub occur downstream from the LCR; it did not offset the concerns of some GCDAMP tribes regarding the location of removal (i.e., from a location standpoint, this was not substantially different from a tribal perspective than removal in the LCR reach); and the cost and effort to implement is essentially the same as conducting more effective removal in the LCR reach. It was not further evaluated in the EA for these reasons.

Turbidity Enhancement through Sediment Augmentation at the Paria River

This proposal would build a sediment slurry pipeline from Lake Powell to the Paria River to augment sediment in the system as defined in a Reclamation feasibility report (Randle et al. 2006). It was proposed as part of several alternatives in the SDM Project because it was thought that the turbidity caused by sediment augmentation would reduce habitat quality for trout in Lees Ferry and downstream throughout Marble and Grand canyons, reducing overall numbers of trout, and reducing predation and competition from trout on humpback chub. Implementing this action would involve large-scale construction, and would be much more expensive to implement than other non-native fish control actions considered (\$430 million, plus an additional \$17 million per year to operate). Many aspects of the action, such as its ecological impacts, require more detailed analysis than could be developed in time to be evaluated in this EA. Construction would take a number of years, and it could thus not be implemented within the timeframe necessary to meet the need for this action. For these reasons, this action was not analyzed further.

Turbidity Enhancement through Lees Ferry Fine Sediment Slurry

This action would have similar effects as the Sediment Augmentation at the Paria River proposal, and would utilize a pipeline to deliver fine sediment to the Colorado River from Lake Powell as defined in Randle et al. (2006). Costs were also similar, \$300 million for construction, and \$7.9 million per year to operate (Randle et al. 2006). It was not further analyzed for the same reasons as the Sediment Augmentation at the Paria River proposal.