RECLAMATION

Managing Water in the West

Environmental Assessment

Non-native Fish Control Downstream from Glen Canyon Dam

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Salt Lake City, Utah

December 30, 2011

Mission Statements

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American Public

Non-native Fish Control Downstream from Glen Canyon Dam

Proposed agency action:	Implementation of non-native fish control downstream from Glen Canyon Dam, Arizona, 2011-2020
Type of statement:	Environmental Assessment
Lead agency:	Bureau of Reclamation, Upper Colorado Region
Cooperating agencies:	Federal: National Park Service, Intermountain Region Bureau of Indian Affairs U.S. Fish and Wildlife Service, Southwest Region U.S. Geological Survey, Pacific Southwest Area Western Area Power Administration State: Arizona Game and Fish Department Tribal: Hualapai Tribe Pueblo of Zuni
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Executive Summary

The Bureau of Reclamation (Reclamation), Upper Colorado Region, proposes to conduct research, monitoring and specific actions to control non-native fish in the Colorado River downstream from Glen Canyon Dam in an effort to help conserve native fish. The non-native fish control efforts would be located within Glen Canyon National Recreation Area (GCNRA) and Grand Canyon National Park (GCNP), Coconino County, Arizona. The purpose of the action is to minimize the negative impacts of competition and predation on an endangered fish, the humpback chub (*Gila cypha*) in Grand Canyon. The action is needed because competition and predation by non-native fishes, and in particular rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), may be contributing to a reduction in survival and recruitment of young humpback chub and threatening the potential recovery of the species. Rainbow trout and brown trout are not native to the Colorado River Basin and have been introduced into the region as sport fish. The action also addresses the concerns of American Indian tribes over the taking of life associated with non-native fish control.

Because non-native fish, particularly rainbow and brown trout, are known to prey on and compete with the endangered humpback chub, the U.S. Fish and Wildlife Service (USFWS) 2008 Final Biological Opinion on the Operation of Glen Canyon Dam (2008 Opinion; U.S. Fish and Wildlife Service 2008) included a conservation measure that addressed non-native fish control. That conservation measure provided that Reclamation would continue non-native fish control efforts through the Glen Canyon Dam Adaptive Management Program (GCDAMP) and anticipated removal of non-native trout at the confluence of the Colorado River mainstem and the Little Colorado River (LCR), as well as other control methods. The conservation measure was further guided by the USFWS 2009 Supplement to the 2008 Final Biological Opinion on the Operation of Glen Canyon Dam (2009 Supplement; U.S. Fish and Wildlife Service 2009) and the 2010 Reissuance of the Incidental Take Statement on the 2009 Supplemental Biological Opinion on the Operation of Glen Canyon Dam 2008-2012 (2010 ITS; U.S. Fish and Wildlife Service 2010a).

Concerns have been expressed by several of the American Indian tribes that are represented on the Adaptive Management Work Group (AMWG), particularly the Pueblo of Zuni, about the taking of life within a place that is sacred to the tribes and fundamental in several creation stories. Reclamation worked with the U.S. Geological Survey (USGS) USGS Patuxent Wildlife Research Center to conduct a Structured Decision Making (SDM) Project to evaluate various potential methods of controlling non-native fish in the Grand Canyon (SDM Project) for this Environmental Assessment (EA). The purpose of the SDM Project was to use a structured approach to develop and provide substantive input to Reclamation for use in preparation of this EA concerning management of non-native fish below the Glen Canyon Dam. The project served to enlist the cooperating agencies and GCDAMP Tribes in alternative

development and analysis. The final report is provided as an appendix to this EA (Appendix A) and has been used to formulate, analyze, and select alternatives in this EA.

The proposed action is to develop further scientific information regarding native and non-native fishes in the Colorado River and take actions to help conserve the endangered humpback chub by controlling numbers of rainbow trout, brown trout, and other non-native fishes, if necessary. The proposed action would likely increase survival of young humpback chub as well as the three other native fish species that occur in the action area, the flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*Catostomus discobolus*), and the speckled dace (*Rhinichthys osculus*). The flannelmouth and bluehead suckers are species that are declining throughout their range and are part of a rangewide conservation plan for native fishes among six western states.

Modeling conducted during the SDM Project indicated that the Proposed Action would have no effect on the Lees Ferry trout population. However, if the proposed action were to reduce total numbers of adult rainbow trout in Lees Ferry, it could result in a healthier, more sustainable population of rainbow trout, with a more balanced age-structure and larger trout of better condition.

Non-native fish control treatments evaluated in the SDM Project and EA processes included flow and non-flow actions to control non-native fish. Although all of these treatments could have desirable effects, based on similar prior actions, there is some uncertainty about the outcome of each treatment if applied individually or in combination with others. The SDM Project was used to identify this uncertainty and analyze the performance of potential actions in reducing non-native fish predation on humpback chub and other objectives, such as cultural resources, hydropower, and recreation. Through the SDM process, and through further analysis in this EA, the proposed action was selected because it best meets the purpose and need to reduce non-native fish predation on humpback chub, reduce uncertainty on aspects of non-native fish control, limit costs of implementing non-native fish control, address concerns by GCDAMP Tribes about the taking of life, and provide the least impact to other resources. A Science Plan to evaluate the proposed action, including a strategy for long-term application and monitoring, is included as an Appendix to this EA (Appendix B).

This Environmental Assessment evaluated the no action and the proposed action relative to the purpose and need for the action. The proposed action was chosen based on its performance in the SDM Project, as will be explained further in "Description of Alternatives" and "Affected Environment and Environmental Consequences" sections. The proposed action is to utilize boat-mounted electrofishing to remove non-native fishes. In any one year, up to 10 non-native fish removal trips would be conducted in the Colorado River below Lees Ferry from the Paria River to Badger Creek Rapid. Removal in the vicinity of the Little Colorado River would only be conducted if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 USFWS Final Biological Opinion on the Operation of Glen Canyon Dam including High Flow Experiments and Non-Native Fish Control (2011 Opinion; U.S. Fish and

Wildlife Service 2011). In this way, fish would only be removed if there is a clear necessity to do so (triggers are reached). Fish would also be removed alive and stocked into other waters to satisfy tribal concerns, or, and only if live removal fails, fish removed would be euthanized for other beneficial use. Up to 6 removal trips would be conducted in the Colorado River near the Little Colorado River from Kwagunt Rapid to Lava Chuar Rapid in each year of the proposed action. The period of the proposed action is up to 10 years, from 2011-2020. The proposed action would be implemented in accordance with a Science Plan designed to utilize adaptive management to learn from implementing non-native fish control actions. Reclamation would continue to evaluate non-native fish control actions through the GCDAMP during the proposed action. Additional flow and non-flow actions not analyzed here would continue to be evaluated and may be added through adaptive management, such as flow actions to suppress recruitment of rainbow trout in Lees Ferry. These actions may require additional environmental compliance.

1.0 Introduction

1.1 *Organization*

The Bureau of Reclamation, Upper Colorado Region (Reclamation) has prepared this environmental assessment (EA) to analyze and disclose the environmental consequences of specific actions designed to develop further scientific information regarding native and non-native fishes in the Colorado River and take actions to control non-native fish in the Colorado River as part of the Glen Canyon Dam Adaptive Management Program (GCDAMP) downstream from Glen Canyon Dam within Glen Canyon National Recreation Area (GCNRA) and Grand Canyon National Park (GCNP), Coconino County, Arizona (Figure 1). This EA analyzes potential effects of implementing the proposed action or alternatives to that action.

This EA describes the current environmental conditions in Glen, Marble, and Grand Canyons downstream from Glen Canyon Dam, and discloses the direct, indirect, and cumulative environmental impacts that could result from the proposed action and alternatives. It describes how the proposed action is designed to control non-native fish species, in particular rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), that have been found to prey on native aquatic species, in the Colorado River in GCNP and GCNRA, and the impacts that would result from the proposed action.

This EA assists in ensuring compliance with the National Environmental Policy Act (NEPA) and in determining whether significant impacts would result from the proposed action or alternatives, in compliance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality regulations for implementing NEPA (40 CFR 1500-1508), and the Department of the Interior regulations implementing NEPA (43 CFR Part 46). If the responsible official determines that there are significant impacts to the human environment based on the analysis presented in this EA, then an environmental impact statement (EIS) may be prepared for the project. If not, a finding of no significant impact (FONSI) may be signed for the EA approving an alternative that may be the proposed action or another alternative. The EA is organized into five chapters.

- *Introduction:* The section includes information on the purpose of and need for the project, the history of the project, and the agency's proposal for achieving the purpose and need. This section also details how the public was notified of the proposal.

- *Description of Alternatives:* This section provides a detailed description of the proposal. One action alternative was developed based on issues raised by the public, other agencies and tribes, and through a Structured Decision Making (SDM) Project to evaluate various potential methods of controlling non-native fish in the Grand Canyon (SDM Project). This section also describes mitigation relative to the proposed action, and monitoring that may be required by Reclamation or the cooperating agencies.

- *Affected Environment and Environmental Consequences:* This section describes the environmental effects of implementing the proposed action compared to the effects of taking no action.

- *Consultation and Coordination:* This section describes agencies consulted during the development of the EA and meetings to facilitate consultation and coordination.

- *References Cited and Appendices:* The appendices provide more detailed information to support the analyses presented in the EA: Appendix A: Non-Native Fish Management below the Glen Canyon Dam, Report from a Structured Decision Making Project; Appendix B: Research and Monitoring Plan in Support of the Environmental Assessment Non-Native Fish Control Downstream from Glen Canyon Dam; Appendix C: Biological Assessment for Non-native Fish Control Downstream from Glen Canyon Dam; Appendix D: Supplement to Biological Assessments for Development and Implementation of a Protocol for High-Flow Experimental Releases and Non-native Fish Control Downstream from Glen Canyon Dam, Arizona, 2011 through 2020; Appendix E: Final Biological Opinion on the Operation of Glen Canyon Dam including High Flow Experiments and Non-Native Fish Control.

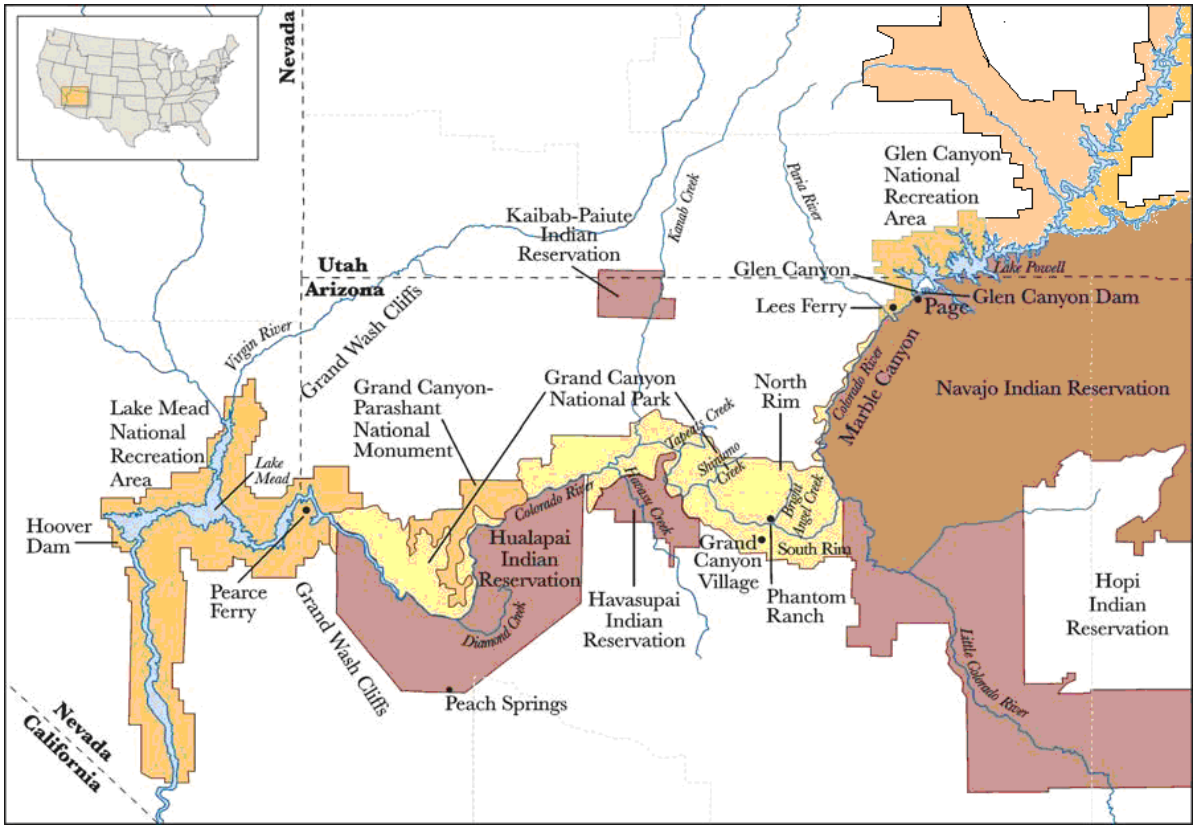

Figure 1. Map of the region that includes the Action Area (courtesy of the U.S. Geological Survey).

1.2 *Purpose of and Need for Action*

The federal action analyzed in this Environmental Assessment is the control of non-native fish in the Colorado River downstream from Glen Canyon Dam within GCNRA and GCNP, Coconino County, Arizona. The purpose of the action is to gain additional scientific information and to reduce the negative impacts of competition and predation by non-native fish on the endangered humpback chub (*Gila cypha*) and its critical habitat in the Grand Canyon. The need for this action is to add to scientific information as part of an adaptive management program and to continue to fulfill the conservation measures and terms and conditions identified in U.S. Fish and Wildlife Service (USFWS) biological opinions, to contribute to the recovery of humpback chub by helping to maintain high juvenile survival and recruitment rates resulting in a stable adult population, and to address concerns expressed by American Indian Tribes over the killing of fish in the Grand Canyon, a location of cultural, religious, and historical importance to a number of tribes. This action is being conducted through the Glen Canyon Dam Adaptive Management Program.

Reclamation proposes that this action extend to 2020. Starting the action promptly addresses several purposes including: the importance and need for implementing non-native fish control activities as soon as possible in order to address the ongoing threat to the humpback chub; the need to offset possible adverse effects of conducting High Flow Experiments (HFEs) through 2020, described in other sections of this document; as well as the need to address a number of cultural and socioeconomic concerns and issues that are further described in other sections of this EA. The 10-year length of the proposed action would allow for sufficient time to evaluate a number of research questions associated with non-native fish control, and would provide any needed mitigation for humpback chub or other native fish associated with the proposed action of implementing a High Flow Experiment Protocol, a separate but related action being evaluated in a separate EA.

1.3 *Proposed Action*

Reclamation proposes to, if necessary, reduce the numbers of non-native fish in the Colorado River downstream from Glen Canyon Dam, Arizona that prey on and compete with endangered humpback chub to meet the requirements of several U.S. Fish and Wildlife Service Endangered Species Act (ESA) section 7 biological opinions concerning the effects of dam operations on the endangered humpback chub. The area of emphasis for reducing numbers of non-native fishes is the confluence of the Colorado and Little Colorado rivers, from river mile (RM) 56 to 66[1] because this area contains the greatest abundance of humpback chub in the lower Colorado River, and impacts from non-native fish, trout species in particular, to humpback chub are greatest in this reach of the river. In order to achieve this reduction, the proposed action, in coordination with related actions, includes reducing emigration of rainbow trout and brown trout from source populations in Glen and Grand Canyon. Non-native fish, predominantly rainbow trout, would be removed from the Paria River to Badger Creek reach (PBR reach, RM 1 to RM 8) using boat-mounted electrofishing. Non-native fish would also be removed from the LCR reach, (RM 56 to 66) using the same

[1] River miles are as measured from Lees Ferry, which is RM 0.

methods, but only if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 U.S. Fish and Wildlife Service Final Biological Opinion on the Operation of Glen Canyon Dam including High Flow Experiments and Non-Native Fish Control (U.S. Fish and Wildlife Service 2011). Fish that are removed would be kept alive and stocked into waters as sport fish in areas that have approved stocking plans, or would be euthanized for later beneficial use identified through continued tribal consultation. As detailed above, the proposed action would take place within GCNRA and GCNP, Coconino County, Arizona, for a 10-year period from 2011-2020. The 10-year length of the proposed action would allow for sufficient time to evaluate a number of research questions associated with non-native fish control, and would provide any needed mitigation for humpback chub or other native fish associated with the proposed action of implementing a High Flow Experiment Protocol, a separate but related action being evaluated in a separate EA.

1.3.1 *Operation of Glen Canyon Dam*

Implementation of non-native fish control would be done in concert with existing coordinated river operations. Since 1970, the annual volume of water released from Glen Canyon Dam has been made according to the provisions of the Criteria for Coordinated Long-Range Operations of Colorado River Reservoirs (LROC) that includes a minimum objective release of 8.23 million acre-feet (maf). The Interim Guidelines for Lower Basin Shortages and the Coordinated Reservoir Operations adopted in 2007 (2007 Colorado River Interim Guidelines) implements relevant provisions of the LROC for an interim period through 2026. The 2007 Colorado River Interim Guidelines allow Reclamation to modify operations by allowing for potential annual releases both greater than and less than the minimum objective release under certain conditions. A more thorough description of Reclamation's process for determining and implementing annual release volumes is available in the 2007 Final Environmental Impact Statement (Reclamation 2007), the 2007 Record of Decision (ROD; U.S. Department of the Interior 2007), and the 2007 Final Biological Opinion for the Proposed Adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mean (2007 Interim Guidelines Opinion; U.S. Fish and Wildlife Service 2007).

The proposed action would be implemented within the framework of continued operation of Glen Canyon Dam under the Modified Low Fluctuating Flow (MLFF; U.S. Department of the Interior 1996) and all applicable prior decisions, with the potential inclusion of a protocol for high-flow experimental releases from Glen Canyon Dam for the same 10-year period, 2011–2020. Annual[2] releases would continue in accordance with prior decisions, including the 2007 Colorado River Interim Guidelines, and including steady flows as identified in the U.S. Fish and Wildlife Service (USFWS) 2008 Final Biological Opinion on the Operation of Glen Canyon Dam (2008 Opinion; U.S. Fish and Wildlife Service 2008) and the USFWS 2009 Supplement to the 2008 Final Biological Opinion on the Operation of Glen Canyon Dam (2009 Supplement; U.S. Fish and Wildlife Service 2009).

[2] 'Annual' in the context of water releases means within the water year, October 1 through September 30, rather than the calendar year.

HFEs may also be implemented during the 10-year period of the proposed action as defined in the Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011 through 2020 Environmental Assessment (HFE Protocol EA; Bureau of Reclamation 2011) depending on the outcome of that NEPA analysis. The HFE Protocol under consideration allows for high flow events during fall (October-November) and spring (March-April) HFE implementation periods. HFEs could range in magnitude and duration from 31,500 cfs to 45,000 cfs and from 1 to 96 hours. The magnitude and duration of an HFE would be in part determined by a model to match existing sediment conditions to the HFE. High flow events under the HFE protocol could potentially require more water than what is scheduled for monthly release through the coordinated operating process. Such adjustments, however, would only be made to the extent they do not interfere with or impact implementation of the 2007 Colorado River Interim Guidelines as contemplated in the 2007 Record of Decision. In order to conduct these high flow events as prescribed by the HFE protocol, reallocation of monthly releases within a water year from Glen Canyon Dam may be necessary. If Reclamation determines that it is not possible to achieve the high flow event within the monthly release volume projected for October-November or March-April, Reclamation would adjust the projected monthly release volumes as necessary for the following December through February period, or May through August period, respectively while ensuring that the annual volume is not affected, nor are water deliveries under the 2007 Colorado River Interim Guidelines. A more complete description of these potential experiments is provided in the HFE Protocol EA.

Although not assessed in this EA, both flow and non-flow control mechanisms that target limiting recruitment of rainbow trout in Lees Ferry would continue to be evaluated through adaptive management. Flow actions might be more economical and effective over the long-term at mitigating the effects of trout on humpback chub. Both flow and non-flow experiments focused on the Lees Ferry reach may be conducted in order to experiment with these actions in reducing recruitment of trout in Lees Ferry, and ultimately the size of the Lees Ferry trout population. This could both reduce numbers of rainbow trout that move downstream into important areas for native fish, and result in improved conditions of the trout fishery in Lees Ferry (e.g. fewer, larger fish). Additional environmental compliance may be necessary for these experiments.

1.4 *Background*

Reclamation proposes to control non-native fish in the Colorado River downstream from Glen Canyon Dam to ensure that its operation of Glen Canyon Dam does not jeopardize the continued existence of endangered native humpback chub. Non-native fish have long been identified as a threat to native aquatic biota (Cambray 2003; Clarkson et al. 2005), and as a specific threat to native fish in the Colorado River and its tributaries in Grand Canyon (Marsh and Douglas 1996; Minckley 1991). Since passage of the Endangered Species Act of 1973 (ESA) and its implementing regulations at 50 CFR 402, Reclamation has consulted with the USFWS to ensure that its operations of Glen Canyon Dam do not jeopardize the continued existence of the endangered endemic Colorado River “big river” fishes, the humpback chub, razorback sucker (*Xyrauchen texanus*), Colorado pikeminnow (*Ptychocheilus lucius*), and bonytail (*Gila elegans*) or destroy or adversely modify their

designated critical habitats. This analysis concentrates on the humpback chub because it is the only one of these species that currently occurs in the project area. The Colorado pikeminnow and bonytail are no longer found in this part of the Colorado River and are not included in this assessment. The razorback sucker would be unaffected by this action because it is absent from the action area and unlikely to occupy the area in the reasonably foreseeable future (this is explained in more detail in Appendix C).

Critical habitat for the Colorado big river fishes was designated by the USFWS in 1994 (50 CFR 17) and includes areas within Marble and Grand canyons. For humpback chub, critical habitat extends for 175 miles of the Colorado River from Nautiloid Canyon (RM 34) to Granite Park (RM 209) and the lower 8 miles of the Little Colorado River (LCR). Critical habitat for razorback sucker in the action area consists of the Colorado River from the Paria River confluence (RM 1) to the Grand Wash Cliffs near Pearce Ferry (RM 277). These reaches of designated critical habitat lie within the boundaries of GCNP and are managed by the National Park Service (NPS). The reach of the Colorado River from RM 30 to RM 75 is a principal nursery area for humpback chub (Figure 2), and it is the reach of river downstream from Lees Ferry that has the highest densities of young humpback chub, and thus impacts of predation and competition by non-native fishes are greatest in this reach. The USFWS critical habitat designation did not include the reach of the Colorado River from RM 30-34, although this area is currently known to be an area of warm springs where humpback chub spawn and apparently recruit (Valdez and Ryel 1995; Andersen et al. 2010).

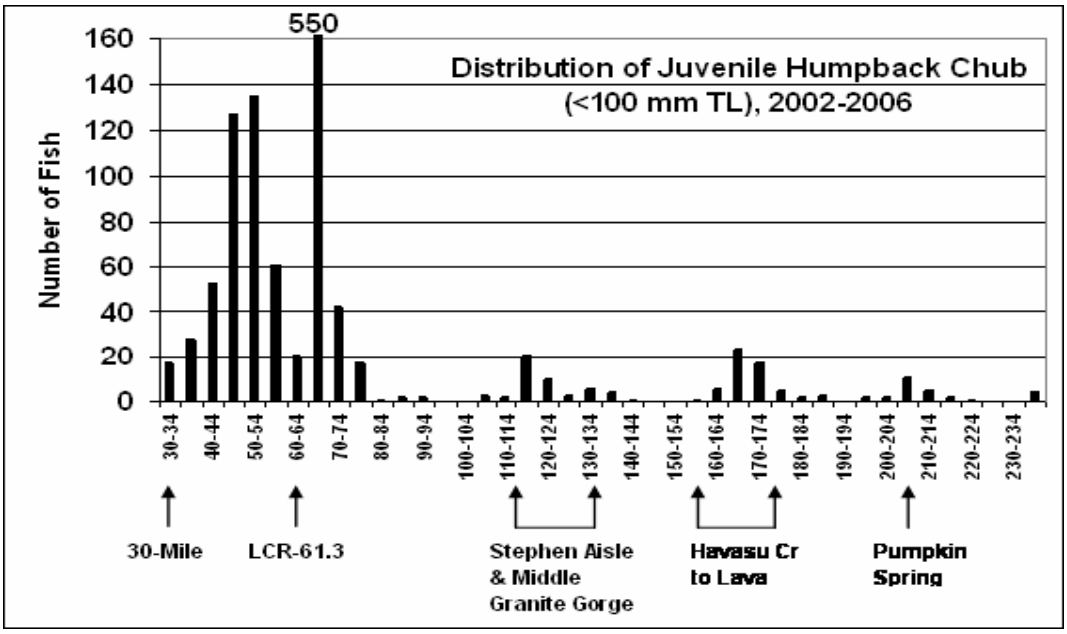

Figure 2. Distribution of juvenile humpback chub<100 mm TL caught during 2002-2006 by 5-mile increments from RM 30 to RM 240. Principal humpback chub aggregations are indicated (data from Ackerman 2008).

The USFWS identified the need for controlling non-native fish species in the recovery goals

for the humpback chub (U.S. Fish and Wildlife Service 2002a)[3]. The focus of non-native fish control in the recovery goals is on controlling the proliferation and spread of non-native fish species that prey on and compete with humpback chub in the mainstem Colorado River. The Recovery Goals identify the need to develop, implement, evaluate, and revise (as necessary through adaptive management) procedures for stocking and other sport fish management actions to minimize out-migration of non-native fish species into the Colorado River and its tributaries through the Grand Canyon, and to develop and implement levels of control for rainbow trout, brown trout, and warm water non-native fish species, to minimize negative interactions between non-native fishes and humpback chub (U.S. Fish and Wildlife Service 2002a).

In prior ESA section 7 consultations on the operation of Glen Canyon Dam, Reclamation and the USFWS have agreed that controlling the numbers of non-native fish that compete with and prey on the endangered fish through the GCDAMP would serve as a conservation measure for Reclamation's dam operations planned through the year 2012. Non-native fish control was identified as a conservation measure in the 2008 Opinion (U.S. Fish and Wildlife Service 2008), the 2009 Supplement (U.S. Fish and Wildlife Service 2009), and the 2010 Reissuance of the Incidental Take Statement on the 2009 Supplemental Biological Opinion on the Operation of Glen Canyon Dam 2008-2012 (2010 ITS; U.S. Fish and Wildlife Service 2010a). Control of non-native fish species in Marble and Grand Canyons through the GCDAMP is also part of the conservation measures identified in the 2007 Interim Guidelines Opinion (U.S. Fish and Wildlife Service 2007). A fourth biological opinion on the cancellation of non-native fish removal trips in 2010, Reinitiation of the 2009 Biological Opinion on the Continued Operations of Glen Canyon Dam without Mechanical Removal of Nonnative Fish in 2010 from the Colorado River, Grand Canyon, Arizona (2010 Cancellation Opinion; U.S. Fish and Wildlife Service 2010b), required as a term and condition that Reclamation:

> "a. Resume nonnative control at the mouth of the LCR in 2011. Attempt to implement the program in a manner compatible with the interests of Tribes and other interested stakeholders.
>
> AND/OR
>
> b. Work with interested Tribes and other parties, expeditiously, to develop options that would move nonnative removal outside of LCR confluence tribal sacred areas in 2011, with the goal that nonnative removal of trout in sacred areas will be reserved for use only to ensure the upper incidental take level is not exceeded." (U.S. Fish and Wildlife Service 2010b).

Also, 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 USFWS Final Biological Opinion on the Operation of Glen Canyon

[3] In 2006, a U.S. District Court ruling set aside the recovery goals, essentially because they lacked time and cost estimates for recovery. The court did not fault the recovery goals as deficient in any other respect. USFWS is in the process of updating the recovery plan and goals for the humpback chub.

Dam including High Flow Experiments and Non-Native Fish Control (2011 Opinion; U.S. Fish and Wildlife Service 2011). The 2011 Opinion replaced all prior biological opinions on the operation of Glen Canyon Dam, including the 2008 Opinion, 2009 Supplement, 2010 ITS, and 2010 Cancellation Opinion.

A panel of independent scientists convened by the U.S. Geological Survey (USGS) also concluded that non-native fish control should continue to be implemented for conservation of humpback chub in Grand Canyon (U.S. Geological Survey 2008). Rainbow trout and brown trout are not native to the Colorado River Basin and were introduced into the region by federal and state agencies as sport fish before and after the 1963 completion of Glen Canyon Dam (e.g., the Arizona Game and Fish Department (AZGFD) stocked rainbow trout at Lees Ferry as recently as 1998). These trout species are the principal competitors and predators of humpback chub, as well as the other native Colorado River fishes, in Grand Canyon (Douglas and Marsh 1996; Valdez and Ryel 1995; Yard et al. 2011). Other species of fish, including the channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), and green sunfish (*Lepomis cyanellus*) also prey upon and compete with the native fishes.

Recent investigations show that negative impacts from trout on native fish are occurring near the confluence of the Colorado and Little Colorado rivers (RM 56-66), where rainbow trout and brown trout co-inhabit the area with the native fish, humpback chub, flannelmouth sucker, bluehead sucker, and speckled dace. The trout species eat juvenile humpback chub and other native fishes and also compete with them for food and space (Yard et al. 2011). This area of the Colorado River supports the largest aggregation of humpback chub in Grand Canyon, and nearshore habitats in the area (talus, vegetated shorelines, and backwaters) are used as nursery areas by young humpback chub originating from the LCR. Wright and Kennedy (2011) found an apparent link between abundances of rainbow trout and humpback chub adult population numbers in Grand Canyon. When rainbow trout populations are large, humpback chub populations generally decline, potentially due to a combination of increased competition and predation, although changes in other ecosystem variables, such as water temperature or flow, could also be responsible for these trends (Coggins 2008a; Coggins and Walters 2009; Coggins and Yard 2010; Coggins et al. 2011; Wright and Kennedy 2011; Yard et al. 2011), and currently populations of both species are high (S. Vanderkoi, GCMRC, pers. comm., 2011). Also, the Grand Canyon population of humpback chub began to improve under the MLFF and prior to many actions and changes in the ecosystem, including removal of non-native fish and warmer river temperatures, beginning approximately in the late 1990s (Coggins and Walters 2009; Yard et al. 2011).

The source of rainbow trout in the LCR reach is not known with certainty, although available data indicate they likely originate in the Lees Ferry reach (first 15 miles below the dam). Brown trout spawn primarily in Bright Angel Creek and are most abundant in the mainstem Colorado River near this tributary (RM 88; Liebfried et al. 2003, 2006). Korman et al. (2010) noted that rainbow trout mortality in Lees Ferry and their emigration from Lees Ferry appear to be density dependent. An important aspect of this action is the need to reduce numbers of rainbow trout and brown trout near the confluence of the Colorado and Little Colorado rivers by reducing the numbers of trout emigrating from these population sources in the Lees Ferry and Bright Angel Creek.

Non-native fish control was previously tested as an experiment from 2003 to 2006 (see Section 1.9; Coggins et al. 2011; Yard et al. 2011). During this time, a removal and related mitigation program was implemented in the mainstem Colorado River at the Little Colorado River confluence (LCR reach). Flows from Glen Canyon Dam designed to reduce recruitment of trout in Lees Ferry were also tested from 2003-2005. Then, as now, removal of non-native fish was focused in the LCR reach because of high numbers of both non-native fishes and native fishes, including the majority of humpback chub in Grand Canyon (Valdez and Ryel 1995; Coggins and Walters 2009). No removal was conducted in the LCR (or is proposed now) because densities of non-native fish in the LCR itself are very low, too low to warrant removal efforts (Valdez and Ryel 1995; Van Haverbeke and Stone 2009). Tribes had expressed concern over non-native fish control when it was first proposed in 2002. Consultation between these tribes, Reclamation, NPS, and the USGS resulted, at that time, in the identification of a beneficial human use that served to mitigate the tribes' concerns for the experimental action. Fish removed were emulsified and used as fertilizer in the Hualapai tribal gardens. The program was effective at reducing numbers of trout and in meeting tribal concerns, although the program was conducted at a time when the trout population was undergoing a natural system-wide decline (Coggins et al. 2011). One removal trip was also conducted in 2009, which prompted concerns from various tribes and ultimately led to preparation of this EA.

As part of the Annual Work Plan of the GCDAMP for Fiscal Year 2010-2011, one or two river trips to remove non-native fish were included and tentatively scheduled for May-June 2010 and 2011. Some tribal representatives to the GCDAMP expressed concern and asked for government-to-government consultation regarding the killing of non-native fish in the vicinity of the confluence of the Little Colorado and Colorado rivers, a location of cultural, religious, and historical importance. The Pueblo of Zuni, in a letter dated June 30, 2009, expressed the Zuni Tribe's concerns with the "taking of life" associated with removal, and stated that the Zuni's believed that the Bureau of Reclamation and the United States Fish and Wildlife Service had failed to consult with the Zuni Tribe concerning this management action, and the Zuni Tribe's request to initiate formal consultation with the Bureau of Reclamation on this issue. After careful consideration of the issues, the Assistant Secretary of the Interior for Water and Science decided to cancel the two planned removal trips in 2010 and Reclamation reinitiated consultation with the U.S. Fish and Wildlife Service on cancelling removal. The Assistant Secretary and other DOI representatives have since conducted numerous meetings with tribal representatives in an effort to find suitable means of addressing the tribal concerns (see Section 1.12).

Reclamation is serving as the lead federal agency in this action because it has operational authority over Glen Canyon Dam and has agreed to address non-native fish control through the GCDAMP pursuant to the terms of the biological opinions issued by the USFWS (U.S. Fish and Wildlife Service 2007, 2008, 2009, 2010a, 2010b). However, Reclamation's legal authority does not include direct management of Colorado River fishes. That authority rests with the NPS, the federal agency responsible for managing natural and cultural resources

within GCNRA and GCNP, and the AGFD, the state agency responsible for managing sport fish in the state of Arizona[4].

1.5 *Structured Decision Making Project*[5]

Reclamation partnered with the USGS Patuxent Wildlife Research Center to conduct a Structured Decision Making (SDM) Project on non-native fish management below the Glen Canyon Dam as part of the process in developing this EA. The purpose of the SDM Project was to use a structured approach to develop and provide substantive input from the cooperating agencies and tribes to Reclamation in the NEPA process concerning management of non-native fish below Glen Canyon Dam. The SDM Project provided an opportunity for the cooperating agencies and tribes to participate in defining objectives for non-native fish control, as well as in developing and evaluating potential alternatives for non-native fish control with regard to their performance in meeting objectives.

Two workshops were held near Phoenix, Arizona, on October 18-20 and on November 8-10, 2010. At these workshops, a diverse set of objectives for the project were defined, a set of alternatives ("hybrid portfolios") was developed, and participants assessed alternatives against the array of objectives. Multi-criteria decision analysis methods were then employed to examine the trade-offs inherent in the problem, and allowed the participating agencies and Tribes to express their individual judgments about how those trade-offs should best be managed in selecting a preferred alternative. Subsequent work refined that analysis. The project served to enlist the cooperating agencies in alternative development and analysis. The final report is provided as an appendix to this EA (Appendix A; Runge et al. 2011) and has been utilized to formulate, analyze, and select alternatives for analysis in this EA were indicated.

The SDM Project was used to assist Reclamation and the cooperating agencies in identifying, developing, and analyzing alternatives as part of the NEPA process. The alternatives considered in the SDM Project were complex, multi-faceted approaches, some with adaptive components. The alternatives were built up from the simplest components and identified several layers of complexity. At the simplest level, the alternatives consist of action elements, which are specific and detailed aspects of on-the-ground actions. Action elements that are related can be combined into single strategies that focus on a particular method for

[4] Because the two park units are not under exclusive federal jurisdiction, state law applies to the management of fish within their boundaries, but only to the extent that it has not been preempted by federal statute, federal regulation, or lawful federal administrative action. In accordance with 43 C.F.R part 24, the NPS must consult with the AGFD before taking certain administrative actions to manage fish within the park units.

[5] The use of the phrase "Structured Decision Making" refers to a process utilized by the U.S. Geological Survey to assess and proceed through a complex set of analyses and resource considerations. In this instance the outcome of the SDM process is not a "decision"; as the SDM process in this instance was utilized as an *input* to the NEPA process. Accordingly, the SDM process does not represent a final agency action and serves in this instance as a method to ensure that the decision agency (Reclamation) had received input from the entities participating in the SDM effort. As described in Appendix A, SDM was used to "provide a forum for the diverse cooperating agencies and Tribes to discuss, expand, and articulate their respective values, to develop and evaluate a broad set of potential management alternatives, and to indicate how they would individually prefer to manage the inherent trade-offs in this management problem."

addressing some aspect of non-native fish control (e.g. mechanical removal of non-native fish at the confluence of the Little Colorado River). The single strategies can also be combined into hybrid portfolios. These hybrid portfolios are the alternatives for long-term non-native fish control, and were evaluated in the SDM Project.

The hybrid portfolios created in the SDM Project were each evaluated by the cooperating agencies and tribes that participated in the SDM Project. These hybrid portfolios essentially serve as NEPA alternatives. The evaluation process is described in detail in the SDM Project report in Appendix A. That process used multi-criteria decision analysis methods to evaluate the performance and impacts of the proposed hybrid portfolios against objectives for the undertaking, and the objectives were derived from the perspective of the cooperating agencies and tribes in the process (defined further in Appendix A). At the second workshop, 20 hybrid portfolios were included in the analysis, and objective weights were elicited from the cooperating agency and tribal representatives to rate the alternatives against the objectives.

A number of portfolios were eliminated from further consideration at that point because their ability to meet objectives was poor and they did not meet the purpose and need. Others were eliminated because they were not well developed and they could not be evaluated. Two high-ranking portfolios, both of which involved sediment augmentation (Randle et al. 2007; discussed further below) were eliminated from further consideration due to cost and because they did not satisfy the purpose and need for the action because the ecological impacts require more detailed analysis than could be developed in time to be evaluated in this EA, and similarly, construction would take a number of years precluding implementation within the timeframe necessary to meet the need for this action. An additional seven hybrid portfolios were created and a total of 13 portfolios were carried forward for final analysis. The final analysis resulted in a ranking of the 5 top-performing hybrid portfolios, performance being measured against the objectives and using methods described in the "Affected Environment and Environmental Consequences" section and in the SDM Project report (Appendix A, section 6). The top-performing hybrid portfolio was selected as the proposed action. The proposed action was then analyzed in this EA against the no action alternative. The "No Action" alternative was also fully analyzed in the SDM Project, and was not in the top five hybrid portfolios at the end of the SDM evaluation. In this way, Reclamation used the SDM Project to help develop analysis of potential alternatives in the NEPA process.

1.6 *Selected Legal Authorities*

The Secretary of the Interior (Secretary) was authorized to "construct, operate, and maintain" Glen Canyon Dam by the Colorado River Storage Project Act of 1956 (CRSPA; 43 U.S.C. § 620):

> "… for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for

> the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes,…"

The CRSPA, as well as a number of Federal statutes and legislative authorities, affect the manner in which Glen Canyon Dam is operated and the manner in which water is apportioned to the seven basin states and Mexico. These authorities are collectively known as the "Law of the River," which is a collection of Federal and State statutes, interstate compacts, court decisions and decrees, an international treaty with Mexico, and criteria and regulations adopted by the Secretary.

An important function and purpose of Glen Canyon Dam is to generate hydroelectric power. Water released from Lake Powell through the dam's eight hydroelectric turbines generates power marketed by Western Area Power Administration (Western). From the time of the dam's completion in 1963 to 1990, the dam's daily operations were primarily undertaken to maximize generation of hydroelectric power in accordance with Section 7 of the CRSPA, which requires hydroelectric powerplants to be operated "so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates."

In the early 1980s, Reclamation undertook the Uprate and Rewind Program to increase powerplant capacity at Glen Canyon Dam. As part of an Environmental Assessment and Finding of No Significant Impact (FONSI; Reclamation 1982), Reclamation agreed to not use the increased capacity until completion of a more comprehensive study on the impacts of historic and current dam operations. The Glen Canyon Dam Environmental Studies (GCES) Phases I and II were conducted from 1982 to 1995 to evaluate the effect of the uprate and rewind and dam operations on downstream resources. The GCES concluded that dam operations were adversely affecting natural and recreational resources and that modified operations would better protect those resources (Reclamation 1988). These studies also brought forth concerns about the effects of dam operations on the resources of GCNP and GCNRA and highlighted the need to evaluate the effects on species listed pursuant to the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. § 1531 et seq.). As a result of these studies, Reclamation agreed to maximum authorized releases of 31,500 cfs, and the potential of 33,200 cfs that resulted from the uprate and rewind was not implemented.

In 1992 Congress enacted, and President George H.W. Bush signed into law, the Grand Canyon Protection Act (GCPA), title XVIII, §§ 1801-1809 of the Reclamation Projects Authorization and Adjustment Act of 1992, Pub. L. No. 102-575, 106 Stat. 4600, 4669. Congress enacted the GCPA to provide further direction to the Secretary to address the detrimental effects of dam operations on downstream resources. Section 1802(a) of the GCPA provides that:

> The Secretary shall operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 and exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use.

At the same time Congress directed the Secretary to implement the GCPA in compliance with other specified provisions of federal law applicable to the operation of Glen Canyon Dam. Section 1802(b) of the GCPA states:

> The Secretary shall implement this section in a manner fully consistent with and subject to the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona v. California, and the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

Similarly, Section 1806 of GCPA states that:

> Nothing in this title [GCPA] is intended to affect in any way—
>
> (1) The allocations of water secured to the Colorado Basin States by any compact, law, or decree; or
>
> (2) Any Federal environmental law, including the Endangered Species Act (16 U.S.C. 1531 et seq.).

Finally, the GCPA emphasized the Secretary's authority and responsibility to manage and administer Grand Canyon National Park and Glen Canyon National Recreation Area in accordance with the so-called NPS Organic Act and other laws applicable to units of the national park system. Section 1802(c) states:

> Nothing in this title alters the purposes for which the Grand Canyon National Park or the Glen Canyon National Recreation Area were established or affects the authority and responsibility of the Secretary with respect to the management and administration of the Grand Canyon National Park or the Glen Canyon National Recreation Area, including natural and cultural resources and visitor use, under laws applicable to those areas, including, but not limited to, the Act of August 25, 1916 (39 Stat. 535) as amended and supplemented.

Section 1804(a) of the GCPA required completion of an EIS evaluating alternative operating criteria, consistent with existing law, that would determine how the dam would be operated consistent with the purposes for which the dam was authorized and the goals for protection of GCNP and GCNRA. The Operation of Glen Canyon Dam Final Environmental Impact Statement was completed in March 1995 (Reclamation 1995) with the preferred alternative, called the MLFF Alternative, selected by the Secretary of the Interior as the required operating regime for Glen Canyon Dam. As articulated in the Record of Decision, issued on October 9, 1996 (Department of the Interior 1996). The goal of selecting a preferred alternative was not to maximize benefits for the most resources, but rather to find an alternative dam operating plan that would permit recovery and long-term sustainability of downstream resources while limiting hydropower capability and flexibility only to the extent

necessary to achieve recovery and long-term sustainability (Department of the Interior 1996).

The final EIS hypothesized that high flows were important for restoring ecological integrity and identified these as beach-habitat building flows and habitat maintenance flows. Additionally, the 1995 Final Biological Opinion on the Operation of Glen Canyon Dam (U.S. Fish and Wildlife Service 1995) identified a program of experimental flows as an element of the Reasonable and Prudent Alternative that included provisions for high-volume dam flows termed "beach-habitat building flows" (BHBFs) and "habitat maintenance flows" (HMFs). BHBFs were releases that exceeded the powerplant capacity and were designed to build sandbars and beaches, and HMFs were releases up to powerplant capacity designed to maintain these sand features. These actions were also discussed in the EIS and the Record of Decision. This biological opinion was replaced by the 2008 Opinion (U.S. Fish and Wildlife Service 2008), which was subsequently supplemented in 2009 (U.S. Fish and Wildlife Service 2009). A more complete history of high-flow releases is provided in section 1.5 of this EA.

Section 1805 of the GCPA directs the Secretary to undertake research and monitoring to determine if dam operations are actually achieving the resource-protection objectives of the Final EIS and Record of Decision, i.e., mitigating adverse impacts and protecting and improving the natural, cultural, and recreational values for which GCNP and GCNRA were established. These provisions of the GCPA were incorporated into the 1996 Record of Decision and led to the establishment of the Glen Canyon Dam Adaptive Management Program (GCDAMP; www.gcdamp.gov). The GCDAMP includes the Adaptive Management Work Group, a chartered Federal Advisory Committee to the Secretary, and the Grand Canyon Monitoring and Research Center (GCMRC), a research branch of the GCDAMP under the U.S. Geological Survey (USGS). Monitoring and research conducted by these organizations since 1996 have improved the understanding of riverine geomorphology and how dam operations might assist in the conservation of sand and other natural and cultural resources below the dam.

Since 1999, the Colorado River Basin has experienced prolonged and historic drought conditions; this period represents the driest period in over one hundred years of streamflow recordkeeping. In response to several years of below-normal runoff and declining reservoir conditions and at the direction of the Secretary, Reclamation completed a Final EIS and Record of Decision in 2007 on the 2007 Colorado River Interim Guidelines (Bureau of Reclamation 2007; U.S. Department of the Interior 2007). These 2007 Colorado River Interim Guidelines were adopted in December 2007 and are scheduled to be in effect through September 2026 to provide better operational management of Lake Powell and Lake Mead. The provisions of the 1995 EIS and 1996 Record of Decision that led to MLFF, as well as the 2007 EIS and Record of Decision that proposed adoption of interim guidelines and coordinated operations, establish the foundation for the no action and proposed action alternatives defined in this EA.

Section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies to consult with agencies designated by the Secretaries of Commerce and the Interior to insure that a proposed agency action is unlikely to jeopardize an endangered or threatened species. The

USFWS and the National Marine Fisheries Service administer the ESA. Once a consultation process is complete, a written biological opinion is issued, which may suggest alternative actions to protect a jeopardized species or its critical habitat. USFWS also administers the FWCA which enables USFWS to provide planning and assistance and recommendations to support conservation of fish and wildlife resources.

1.7 *Related Actions, Projects, Plans and Documents*

Related actions, projects, plans, and documents are identified in this EA in order to better understand other ongoing activities that may individually or cumulatively influence, relate to, or affect the proposed action. These actions, project, plans, and documents are related to ongoing activities of state and federal agencies, as well as American Indian Tribes. There are relatively few actions that cumulatively impact the affected environment because the location of the proposed action is the Colorado River in Glen, Marble, and Grand Canyons, almost entirely in national parks, GCNP and GCNRA.

1.7.1 *1995 Glen Canyon Dam Environmental Impact Statement and Record of Decision*

The action proposed in this EA is tiered from two Reclamation EISs and these documents are incorporated by reference: the 1995 EIS on the operation of Glen Canyon Dam (Bureau of Reclamation 1995) and the associated 1996 Record of Decision (U.S. Department of the Interior 1996); and the 2007 Colorado River Interim Guidelines EIS (Bureau of Reclamation 2007) and the associated 2007 ROD (U.S. Department of the Interior 2007). The 1996 Record of Decision implemented the MLFF to govern releases from Lake Powell at monthly, daily, and hourly increments. The 2007 ROD governs annual water year releases from Lake Powell in coordination with Lake Mead. There is also an ongoing program of experimental releases from Glen Canyon Dam in effect from 2008 through 2012, under an EA and FONSI (Bureau of Reclamation 2008).

1.7.2 *High Flow Experiment Protocol Environmental Assessment*

In a concurrent NEPA process, Reclamation is preparing an EA to evaluate implementation of a protocol for conducting HFEs at Glen Canyon Dam for the purposes of sediment management in Grand Canyon. The protocol would be implemented over a period of up to 10 years, from 2011 through 2020. The HFE Protocol, if implemented, would be a multi-year, multi-experimental approach using short-duration, high-volume releases from Glen Canyon Dam in the channel of the Colorado River downstream of the dam. The purposes of the HFE Protocol are: 1) to develop and implement a protocol that determines when and under what conditions to conduct experimental high volume releases, and 2) to evaluate the effectiveness of these experimental releases in conserving sediment to benefit downstream resources in Glen, Marble, and Grand Canyons without affecting annual releases from Glen Canyon Dam under the 2007 Colorado River Interim Guidelines.

High-flow releases have been one mechanism that have historically been used to comply with the Grand Canyon Protection Act to restore beaches and associated resource values in Grand Canyon. However, past Spring HFEs have had demonstrated effects on some non-

native fish species in Grand Canyon, and future HFEs could have similar effects (Wright and Kennedy 2011). Specifically, high flow releases may lead to increased rainbow trout populations, perhaps depending on the time of year of the HFE (Korman et al. 2010, Wright and Kennedy 2011). In turn, this may increase the threat to humpback chub from predation and competition from increased numbers of non-native fish (Wright and Kennedy 2011). Non-native fish control alternatives should be developed that would allow effective control of trout while enhancing conditions for humpback chub in consideration of the potential effects of increased HFE occurrence on trout abundance. Accordingly, this EA takes into account the potential effects of HFEs in the context of no action and the proposed action, and analyzes a 10-year period of implementation of non-native fish control to correspond with the 10-year period of the proposed action in the HFE Protocol EA.

1.7.3 *Other Agency Actions, Projects, Plans, and Documents*

The NPS actively manages resources within GCNP and GCNRA. Of importance to this EA is the GCNP and GCNRA ongoing effort related to native fish management. NPS is in the process of developing a Native Fish Plan for GCNP and the Colorado River in GCNRA. Management goals for native fisheries in Glen Canyon and Grand Canyon are being developed to achieve a "natural condition," or the condition of resources that would occur in the absence of human dominance over the landscape (NPS Management Policies 2006). In general, the NPS seeks to restore native fish communities and naturally functioning ecosystems. The overall goals of the Native Fish Plan include:

- Restore populations of native fish to a level that approximates natural conditions, and prevent adverse modification to their habitat (including critical habitat for ESA-listed species).

- Restore self-sustaining populations of extirpated fish species, including Colorado pikeminnow, razorback sucker, bonytail, and roundtail chub (*Gila robusta*), to the extent feasible within GCNP.

- Minimize the impacts of the recreational trout fishery in the Lees Ferry reach to downstream native fisheries in GCNP.

Specific actions underway include:

- Translocation of humpback chub to Shinumo Creek and Havasu Creek: juvenile humpback chub have been translocated from the Little Colorado River to Shinumo Creek. Plans are in place to make additional translocations of humpback chub to Havasu Creek. These translocations are a conservation measure of the 2008 Opinion, the 2009 Supplement, and the operating biological opinion, the 2011 Opinion (U.S. Fish and Wildlife Service 2008, 2009, 2011).

- Non-native fish are being removed from Bright Angel and Shinumo Creeks to restore and enhance the native fish community in Bright Angel Creek and to reduce predation and competition on endangered humpback chub from non-native fish. Non-

native fish (rainbow and brown trout) are being removed from Shinumo Creek in conjunction with translocation to minimize predation upon newly translocated humpback chub and reduce potential competitive interactions. 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; NPS also removed 1,220 rainbow trout and one brown trout from Shinumo Creek in 2009, and 929 rainbow trout in 2010. These efforts are a conservation measure of the 2008 Opinion, the 2009 Supplement, and the 2011 Opinion (U.S. Fish and Wildlife Service 2008, 2009).

In addition to the above, the following are related actions identified by the NPS. The NPS is a cooperating agency in this EA and all actions identified in this document are being coordinated with that agency.

- GCNRA General Management Plan (GMP): The recreation area's 1979 GMP set an objective to manage the Lees Ferry and Colorado River corridor below the Glen Canyon Dam to "give primary emphasis to historical interpretation and access to recreational pursuits on the Colorado River" (NPS 1979).
- General Management Plan (GMP): The park's 1995 GMP set as an objective the management of the Colorado River corridor through Grand Canyon National Park to protect and preserve the resource in a wild and primitive condition (National Park Service 1995).
- Grand Canyon National Park Resource Management Plan (RMP) (1997): The RMP is the primary resource stewardship action plan that provides long-term guidance and protection for natural, cultural and recreational resources of GCNP (National Park Service 1997).
- Colorado River Management Plan (CRMP): The CRMP management objectives emphasize managing river recreation to minimize impacts to resources while providing a quality river visitor experience. The Colorado River corridor will be managed to provide a wilderness-type experience in which visitors can intimately relate to the majesty of the Grand Canyon and its natural and cultural resources. Visitors traveling through the canyon on the Colorado River will have the opportunity for a variety of personal outdoor experiences, ranging from solitary to social, with little influence from the modern world. The Colorado River corridor will be protected and preserved in a wild and primitive condition. To ensure these salient objectives are met, the NPS must determine, through a research, monitoring and mitigation program, what impacts are occurring, how these impacts alter resource condition, and how adverse impacts can be effectively mitigated. The NPS has developed a draft plan that includes individual and integrated resource-monitoring components.
- Backcountry Management Plan: This plan describes provisions for back country use, resource and wilderness management within Grand Canyon National Park. The plan

is being updated in 2011.

The Arizona Game and Fish Department (AGFD) is also a cooperating agency in this EA. The following are related actions identified by that State agency.

- Changes to bag limits: the AGFD and the Arizona Game Commission changed size limits and bag limits for trout in the Lees Ferry reach in 2010. These changes are designed to better manage abundance and size of trout in the Glen Canyon trout fishery, and to reduce the numbers of trout emigrating downstream to habitat occupied by humpback chub, where they prey upon and compete with this endangered fish species. Two river reaches and corresponding regulations were redefined: Paria Rifle (RM 1) to Navajo Bridge (RM 4) – 6 rainbow trout/day, 8 in possession; unlimited take of all other sport fish other than rainbow trout; and unlimited take of all sport fish from Navajo Bridge (RM 4) to Separation Canyon (RM 239.5) including all tributaries within Grand Canyon National Park.

- USFWS intra-Service consultation on Arizona Game and Fish Department stocking of sport fish in the State of Arizona outside of GCNP and the GCNRA.

1.8 *Agency Roles and Responsibilities*

Five agencies within Interior and one within the U.S. Department of Energy have responsibilities under the GCPA, and undertake operations pursuant to the GCPA. The role of each responsible agency under the GCPA is briefly addressed below.

1.8.1 *Department of the Interior*

1.8.1.1 Bureau of Indian Affairs

The Bureau of Indian Affairs' (BIA) mission, among other objectives, includes enhancing quality of life, promoting economic opportunity, and protecting and improving trust assets of American Indian Tribes and individual American Indians. This is accomplished within the framework of a government-to-government relationship in which the spirit of Indian self-determination is paramount. As part of the GCDAMP, BIA's Western Regional Office is committed to working hand-in-hand with interested tribes and other participating agencies to ensure that this fragile, unique, and traditionally important landscape is preserved and protected.

1.8.1.2 Bureau of Reclamation

Reclamation operates Glen Canyon Dam pursuant to applicable federal law and in accordance with the additional criteria and operating plans specified in section 1804 of the Grand Canyon Protection Act as well as in accordance with approved experimental plans. Glen Canyon Dam is also operated consistent with and subject to numerous compacts, federal laws, court decisions and decrees, contracts and regulatory guidelines commonly and collectively known as the "Law of the River."

1.8.1.3 National Park Service

The NPS manages and protects units of the national park system and administers resource-related programs under the authority of various federal statutes, regulations, and executive orders and in accordance with written policies set forth by the Secretary and the Director of the NPS, including the NPS Management Policies 2006 and the NPS Director's Orders. The NPS manages GCNP and GCNRA under the Organic Act (16 U.S.C. §§ 1 and 2-4, as amended); other acts of Congress applicable generally to units of the national park system; and the legislation specifically establishing those park units (16 U.S.C. §§ 221-228j and 16 U.S.C. §§ 460dd through 460dd-9 (2006)). The Organic Act directs the NPS to *"promote and regulate the use of . . . national parks . . . in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."* The agency emphasis is not only on preserving species and habitat, but also on maintaining natural processes and dynamics that are essential to long-term ecosystem perpetuation.

1.8.1.4 U.S. Fish and Wildlife Service

The USFWS provides Endangered Species Act (ESA) conservation and associated consultation and recovery with various stakeholders primarily to benefit four ESA-listed species in Grand Canyon: humpback chub, razorback sucker, southwestern willow flycatcher (*Empidonax trailii extimus*), and Kanab ambersnail (*Oxyloma haydeni kanabensis*).

The USFWS also provides Fish and Wildlife Coordination Act (FWCA) planning assistance and recommendations to support conservation of important fish and wildlife resources. Of special concern to the USFWS is the opportunity provided under the FWCA for collaborative development of recommendations to conserve non-listed native species such that the need for listing in the future under the ESA is unnecessary.

A FWCA report (June 28, 1994) provided recommendations that included timing for flows, protection of juvenile humpback chub and other native fish, and trout management, in support of preparation of the 1995 EIS. This information was provided to support conservation of fish and wildlife, including endangered species, in GCNP and GCNRA.

1.8.1.5 U.S. Geological Survey

The Grand Canyon Monitoring and Research Center (GCMRC) of the U.S. Geological Survey (USGS) was created to fulfill the mandate in the GCPA for the establishment and implementation of a long-term monitoring and research program for natural, cultural, and recreation resources of GCNP and GCNRA. The GCMRC provides independent, policy-neutral scientific information to the GCDAMP on: (a) The effects of the operation of Glen Canyon Dam and other related factors on resources of the Colorado River Ecosystem using an ecosystem approach, and (b) the flow and non-flow measures to mitigate adverse effects. GCMRC activities are focused on: (a) monitoring the status and trends in natural, cultural and recreation resources that are affected by dam operations, and (b) working with land and resource management agencies in an adaptive management framework to carry out and evaluate the effectiveness of alternative dam operations and other resource conservation actions.

1.8.2 *Department of Energy*

1.8.2.1 Western Area Power Administration

Western's mission is to market and deliver clean, renewable, reliable, cost-based federal hydroelectric power and related services. The Colorado River Storage Project (CRSP) Management Center markets power from the CRSP and its participating projects (Dolores and Seedskadee and the Collbran and Rio Grand projects). These resources are provided by 11 powerplants in Arizona, Colorado, New Mexico, Utah and Wyoming and are marketed together as the Salt Lake City Integrated Projects. CRSP staff also markets power from the Provo River Project in Utah and the Amistad-Falcon Project in Texas. Transmission service is provided on transmission facilities in Arizona, Colorado, Nevada, New Mexico, Texas, Utah and Wyoming.

1.9 *Previous Non-native Fish Control Efforts*

Non-native fish control was previously tested from 2003 to 2006, and in 2009. During this time, a removal and related mitigation program was implemented in the vicinity of the Colorado and Little Colorado rivers confluence (the LCR reach). Flows from Glen Canyon Dam, "non-native fish suppression flows," designed to reduce recruitment of trout in Lees Ferry were also tested from 2003-2005. Tribes had expressed concern over non-native fish control when it was first proposed in 2002. Consultation between these tribes, Reclamation, and the USGS resulted, at that time, in the identification of a beneficial human use that served to mitigate the tribes' concerns for the experimental action; fish removed were emulsified and used as fertilizer in the Hualapai tribal gardens. The program was effective at reducing numbers of trout and in meeting tribal concerns, although subsequent studies indicate that the program was conducted at a time when the trout population was undergoing a natural system-wide decline, and other ecosystem changes, including warmer water temperatures, confounded efforts to evaluate the response of native fishes to the control efforts (Coggins et al. 2011).

Several key results were derived from this period of experimentation. Although the "non-native fish suppression flows" did result in a total redd[6] loss estimate of 23% in 2003 and 33% in 2004, this increased mortality did not lead to reductions in overall recruitment due to increases in survival of rainbow trout at later life stages (Korman et al. 2005; Korman et al. 2011). Removal of non-native fish using boat-mounted electrofishing in the LCR reach was effective for both rainbow trout and brown trout removal. Of 36,500 fish captured from 2003-2006, 23,266 were non-native, including 19,020 rainbow trout and 470 brown trout. Levels of both trout species were effectively suppressed in the LCR reach using this method, especially rainbow trout, which dropped from an initial estimated abundance of 6,466 in January of 2003 to a low of 617 in February 2006 (Coggins et al. 2011). During the period of removal, the humpback chub population stabilized and increased, indicating that removal had enabled higher survival and hence, recruitment by humpback chub (Coggins 2008a; Coggins and Walters 2009; Coggins and Yard 2010). However, a system-wide decrease in rainbow trout abundance concurrent with removal and drought-induced increases in river

[6] A redd is a fish "nest" where spawning occurs and fertilized eggs are buried.

water temperature confounded efforts to determine with certainty the causes of apparent increases in juvenile native fish survival and recruitment (Coggins et al. 2011).

Although diet content analysis indicated that rainbow trout predation rate on humpback chub was relatively low, the overall loss of young humpback chub to predation by rainbow trout was substantial due to the high density of rainbow trout in the reach. Yard et al. (2011) found that during the 12 removal trips conducted from 2003-2004, 9,326 humpback chub were eaten by trout. Therefore reducing numbers of rainbow trout in the LCR reach (19,020 rainbow trout were removed) effectively reduced predation losses of young humpback chub, a clear beneficial effect to the species, although other factors, such as warmer mainstem water temperatures in Grand Canyon during this period, confounded the overall effect of removal on humpback chub recruitment in the system (Andersen 2009; Coggins et al. 2011; Yard et al. 2011). Also during this period, rainbow trout declined system-wide, indicated both by abundance estimates from the control reach of the non-native control project and from monitoring throughout the system (Coggins et al. 2011; Makinster 2007).

The decline of rainbow trout abundance observed in the control reach may have been due to several factors. First, rainbow trout abundance in the Lees Ferry reach of the Colorado River increased during approximately 1992-2001 and then steadily fell during 2002-2006 (Makinster 2007). The 2002-2006 decrease took place during the period of removal, but upstream 60 miles in Glen Canyon. This illustrates that there was a system-wide decline in rainbow trout at the same time removal was occurring in the LCR reach. So while removal directly reduced trout numbers in the LCR reach, system-wide, rainbow trout were also declining, and it is unlikely that removal alone resulted in the decline. The decline in trout was more likely due to other factors. Possible causes include a system-wide reduction in flow and increases in water temperature due to drought, changes that could have affected the Lees Ferry rainbow trout population by reducing food base and thus creating less suitable conditions for survival and growth.

One non-native removal trip was also conducted in 2009, which provided important information for consideration of non-native fish control efforts (Makinster et al. 2009). Results from the 2009 trip indicated that rainbow trout populations rebounded since declines in 2006-2007, a trend first documented in 2008 (Coggins 2008a). AGFD removed 1,873 rainbow trout during the 2009 removal trip. The numbers of rainbow trout in 2009 in the LCR reach prior to removal are estimated to be similar to the high densities observed in 2002. Wright and Kennedy estimate that about 6-7,000 rainbow trout occupied the reach in 2002 and 2009, although these estimates are based on catch per unit effort, a less accurate measure than other methods such as catchability coefficients used by Coggins et al. (2011). By comparison, removal efforts from 2003-2006 reduced the rainbow trout population to a low of 617 in February 2006 (Coggins et al. 2011).

1.10 *Role of Adaptive Management in Non-native Fish Control*

The proposed action in this EA for non-native fish control would be conducted as a component of the ongoing Glen Canyon Dam Adaptive Management Program. The GCDAMP is administered through a designated senior Department of the Interior (DOI)

official who chairs the Adaptive Management Work Group (AMWG). The AMWG provides advice and recommendations to the Secretary of the Interior relative to the operation of Glen Canyon Dam, in accordance with the additional criteria and operating plans specified in Section 1804 of the GCPA, and to the exercise of other authorities under existing laws in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including but not limited to natural and cultural resources and visitor use, as provided in Section 1802 of the Act.

The decision to conduct non-native fish control would be informed by scientists and federal managers in determining the need for non-native fish control and would be based on the numbers and location of non-native fish in the system, as described in section 2 of this document. The decision would also include consideration of the concerns expressed by American Indian Tribes and Pueblos during the NEPA process. This intersection of scientists and managers is a fundamental principle of adaptive management and uses the best available scientific information to make decisions about management of the ecosystem relative to dam operations. The AMWG would continue its role as advisor to the Secretary on this 10-year proposed action and the adaptive management process. The 10-year non-native fish control action is intended to build on prior efforts of the GCDAMP to control non-native fishes through "learning by doing," which is a fundamental principal of adaptive management.

A Science Plan is attached to this EA for the proposed action (see Appendix B). This plan addresses research and monitoring activities necessary to evaluate non-native fish control and the effects of both control and related actions such as experimental releases from the dam. The plan was developed by GCMRC and its cooperating scientists with consultation/coordination with the cooperating agencies. Members of the GCDAMP and the general public were afforded an opportunity to comment on the plan through the public review process for the EA. Key research questions that would be addressed in the Science Plan include, but are not be limited to:

- Research Question #1: Can a decrease in the abundance of rainbow trout and other cold- and warm- water non-natives in Marble and eastern Grand canyons be linked to a higher recruitment rate of juvenile humpback chub in the adult population relative to other potential sources of mortality? Or conversely, can an increase in numbers of non-native fish predators be linked to a decrease in adult humpback chub?

  Rationale: The goal of the proposed action is, in part, to determine if humpback chub recruitment can be improved by controlling non-native fish species, and in particular, rainbow and brown trout.

- Research Question #2. Can removal efforts focused in the PBR reach (e.g., interception fishery) be effective in reducing downstream movement of trout such that trout levels in the LCR reach remain low? Will recolonization from tributaries, from downstream and upstream of the removal reach, or local production require that removal be an ongoing management action in the LCR reach?

Rationale: Although previous efforts to reduce trout numbers in the LCR reach were effective, they were conducted during a period of decreasing trout abundance throughout the system. This control effort would assess whether reductions in numbers of trout, and other non-native fish species, can be sustained while also reducing effort and cost of control actions.

- Research Question #3: Can non-native fish control offset any increases in rainbow trout from multiple HFEs?

  Rationale: Ongoing research and monitoring of fish populations downstream from Glen Canyon Dam have shown that the status and trends of these populations are influenced by complex interactions of river flows, water temperature, water clarity, and tributary influences. The humpback chub population declined from about 11,000 adults in 1989 to about 5,050 adults 2001, and has subsequently stabilized and increased to 7,650 adults in 2008. Korman et al. (2011) found that the March 2008 HFE resulted in increased productivity of trout in Lees Ferry, and Makinster et al. (2010) found that this appeared to be linked to increased emigration rates, and ultimately contributed to higher numbers of trout in the LCR reach. Wright and Kennedy (2011) also reported that the 2008 HFE appears to have contributed to an increase in rainbow trout numbers in the LCR reach. Focused investigations are needed to better understand how aspects of an HFE (timing, magnitude, duration, and frequency) affect fish populations, including nearshore habitat, movement of young native fish from the Little Colorado River, recruitment of young, and food base. Due to the proposed HFE Protocol and the potential for future HFEs, non-native fish control efforts would need to be evaluated with regard to their efficacy at offsetting increases in rainbow trout that result from HFEs.

- Research Question #4: What is the importance of mainstem habitats to humpback chub recruitment relative to the LCR?

  Rationale: A long standing question of humpback chub recovery has been what is the relative importance of mainstem habitats to humpback chub recruitment? Much of the recruitment of humpback chub is thought to occur in the LCR. Non-native fish control actions would improve survivorship of humpback chub predominantly in the mainstem. However, if a vast majority of recruitment is occurring in the LCR, potential improvements in survivorship in the mainstem through non-native fish control may have relatively little effect on overall recruitment of humpback chub. Better estimates of juvenile humpback chub abundance and survivorship in both the LCR and the mainstem would be required to answer this question.

The proposed action includes both PBR reach and LCR reach removal. Removal efforts would be implemented through adaptive management. The goal of the proposed action is to reduce predation and competition from non-native fishes on humpback chub while continuing to address the concerns of American Indian tribes surrounding non-native fish removal. Through adaptive management, effort would be shifted between the two removal

reaches depending on the results of removal actions and the status of native and non-native fishes reported through monitoring and modeling results.

In order to both address the concerns of American Indian tribes over non-native fish removal, and to better understand the relationship between predation by rainbow trout on humpback chub survivorship, removal at the LCR would only be implemented if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 Opinion (see appendix E, U.S. Fish and Wildlife Service 2011). Reclamation proposes to use this trigger for LCR reach removal because this is consistent with the USFWS biological opinion on this action.

The proposed action would also include research to better understand trout movement dynamics in the action area, as well as the relative importance of habitats in the Little Colorado River and mainstem Colorado River to juvenile humpback chub. Rainbow trout would be marked with PIT tags in the Lees Ferry area, and monitoring in Marble Canyon would be increased. This additional monitoring, along with pilot testing of PBR reach removal, should assist in evaluating how and when trout move from the Lees Ferry area to downstream reaches. The proposed action would also include new research on habitat use and abundance of juvenile humpback chub in both the Little Colorado River and the mainstem Colorado River to assess the relative importance of mainstem habitats to humpback chub recruitment.

As part of the adaptive management process, Reclamation would undertake development of suppression options, with stakeholder involvement, that 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 with actions that would reduce the recruitment of trout in Lees Ferry, lowering emigration of trout. These actions may also serve to improve conditions of the recreational trout fishery in Lees Ferry. Additional environmental compliance may be necessary for these experiments. Utilizing actions such as Glen Canyon Dam releases to reduce recruitment and emigration rates of trout in Lees Ferry may be more economical and effective over the long-term at mitigating the effects of trout on humpback chub (Runge et al. 2011). However, 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 determine the extent to which non-native fish control is necessary and 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 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 evaluating these flow and non-flow actions with these groups over the next one to two years.

1.11 *Public Involvement*

Based on the previous experiments and before beginning preparation of this EA, a wide variety of people were contacted to get their ideas and concerns about the status of endangered fish in the Colorado River and possible treatments to reduce numbers of non-native fish, as well as the anticipated effects of these treatments. The Grand Canyon Monitoring and Research Center convened and conducted a Non-native Fish Workshop on March 30-31, 2010, to: (1) Describe non-native fish management in Grand Canyon, (2) identify critical issues and develop approaches to these issues, describe perspectives on management of native and non-native species, and (3) describe agency roles for non-native fish control in conservation and recovery of native fish in Grand Canyon. Two modeling workshops were also held by GCMRC on April 14-15 and on October 12-15, 2010 that helped to clarify the role of trout predation on the humpback chub and preliminarily identified possible strategies and treatments for managing trout populations in Grand Canyon.

The following cooperating agency (CA) meetings were also held:

- A cooperating agency workshop was conducted in Salt Lake City June 17-18, 2010;

- A CA and tribal meeting was held in Flagstaff on August 20, 2010; and,

- CA conference calls were conducted on July 12, September 2, 9, 16, 23, 30, and November 4 and 21, 2010, and January 5, 2011, and March 24, 2011.

- SDM Workshops were conducted on October 18-20, November 8-10, 2010.

- AZGFD met with Marble Canyon business owners on January 28th 2011 to discuss the EAs; USGS, NPS, and Western were also in attendance.

- The AZGFD, USFWS, Reclamation, NPS, USGS, and Western also met with flyfishing guides and Marble Canyon business owners to discuss their concerns

> regarding removal on April 16, 2010, and Reclamation met separately with the Marble Canyon business owners on August 20 and December 20, 2010.

The draft EA was published on January 28, 2011 for a 30-day public review and comment period. In response to requests from the interested public, the comment period was extended to March 18, 2011. Thirty-five comment letters or emails were received and were fully considered in making revisions to the draft EA. This revised draft EA was circulated again for a two-week public review and comment period on July 5, 2011 in order to provide the interested public the opportunity to review revisions to the previously published draft EA; this public comment period closed on July 26, 2011. There were 15 public comments received during the second comment period which were fully considered in making revisions to the final EA.

1.12 *Consultation with American Indian Tribes*

Reclamation has a responsibility to recognize Indian Trust rights and maintain compliance with section 106 of the National Historic Preservation Act (NHPA), which forms part of the need for this EA. The Federal government holds Trust responsibilities that recognize the sovereign status and management authority of tribes, and assures the tribes that federal agencies will not knowingly compromise traditional practice and livelihoods in execution of their duties. Executive Order 13007 adds specificity to this principal in stating that federal agencies "shall avoid adversely affecting the physical integrity of sacred sites," while Secretarial Order 3206 stipulates that within the context of the ESA the "Departments will carry out their responsibilities under the Act in a manner that harmonizes the Federal trust responsibility to tribes." Further, the NHPA requires federal agencies to take into account the effects of their actions on historic properties, which, through the National Register of Historic Places, includes special provisions for places of cultural and religious importance.

Reclamation also has a responsibility to consult with tribes on actions it undertakes under Presidential Executive Order 13175, which was enacted on November 6, 2000, "in order to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes." President Barrack Obama also recently issued a memorandum on November 5, 2009 that further refined this responsibility, stating:

> My Administration is committed to regular and meaningful consultation and collaboration with tribal officials in policy decisions that have tribal implications including, as an initial step, through complete and consistent implementation of Executive Order 13175. Accordingly, I hereby direct each agency head to submit to the Director of the Office of Management and Budget (OMB), within 90 days after the date of this memorandum, a detailed plan of actions the agency will take to implement the policies and directives of Executive Order 13175.

Non-native fish control was first implemented through the GCDAMP beginning in 2002 with a proposal to utilize removal in the LCR reach and altered flow regimes at Glen Canyon Dam

to control trout numbers in the system. At the time, several tribes expressed concern over the taking of life associated with the project in a culturally important place, both the Grand Canyon as a whole, and the confluence of the LCR and Colorado River in particular. The Hopi Tribe, the Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, the Hualapai Tribe, and the Zuni Tribe objected to the experimental action of removal unless there was a beneficial human use for fish removed. Consultation between these tribes, Reclamation, and the USGS resulted in the identification of a beneficial human use that served to mitigate the tribes' concerns for the experimental action. Fish that were removed were emulsified and used for fertilizer at the Hualapai tribal gardens. From 2003 through 2006 and in 2009, a removal and related mitigation program was implemented in the vicinity of the Colorado and Little Colorado rivers confluence (LCR reach). The program was effective at reducing numbers of trout, although the program was conducted at a time when the trout population was undergoing system-wide decline.

As part of the Annual Work Plan of the Glen Canyon Dam Adaptive Management Program for Fiscal Year 2010-2011, one or two river trips to remove non-native fish were included and tentatively scheduled for May-June 2010 and 2011. Some tribal representatives to the program expressed concern and asked for government-to-government consultation regarding the killing of non-native fish in the vicinity of the confluence of the Little Colorado and Colorado rivers, a location of cultural, religious, and historical importance. The Pueblo of Zuni, in a letter to Larry Walkoviak, dated June 30, 2009, from Zuni Governor Norman J. Cooeyate, expressed the Zuni Tribe's concerns with the "taking of life" associated with removal, and their concern that Reclamation and the USFWS had not sufficiently consulted with the Zuni Tribe concerning this management action. The letter also requested initiation of formal tribal consultation with the Bureau of Reclamation on this issue. In response, Reclamation and other DOI representatives met with Zuni tribal leaders to hear their concerns on September 15, 2009.

A meeting of DOI and tribal representatives was held on January 12-13, 2010, where the tribes requested government-to-government consultation on the proposed removal. Tribal concerns were also expressed in February 2010, as part of a 2-day series of GCDAMP-related public meetings in Phoenix, Arizona. The Pueblo of Zuni sent a letter to the Assistant Secretary of the Interior for Water and Science on February 19, 2010, in which the Governor of Zuni expressed his dissatisfaction with the nature and content of consultation that had occurred to date regarding non-native fish control. In response, in March 2010, Reclamation cancelled the two planned non-native fish removal trips in 2010 and reinitiated consultation with the U.S. Fish and Wildlife Service on cancelling removal.

The Assistant Secretary met with Pueblo of Zuni Governor Cooeyate and the Tribal Council on August 5, 2010, in Zuni, New Mexico. The Pueblo later sent Reclamation a Zuni Tribal Council Resolution (No. M70-2010-C086), a document and formal position statement generated by the Executive and Legislative Branches of the Zuni Government, that clearly stated the position of the Zuni Tribe and religious leaders concerning the adverse effects to the Pueblo from the removal of non-native fish in Grand Canyon and also explaining that the Zuni Tribe believes the Grand Canyon and Colorado River are Zuni Traditional Cultural Properties eligible for inclusion to the National Register of Historic Places. The resolution

included a position statement by the Zuni Religious leaders that explained that all life and the entire environment in Grand Canyon is sacred to the Zuni people and that mechanical removal results in counterproductive energy and negative effects to the Zuni people and all life.

Government-to-government consultation was initiated with the Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, San Juan Southern Paiute Tribe, Las Vegas Paiute Tribe, Moapa Band of Paiutes, Navajo Nation, the Havasupai Tribe, the Yavapai Apache Nation, the Pueblo of Jemez, and Pueblo of Zuni regarding the proposed action, and consultation is continuing. The Hualapai Tribe and Pueblo of Zuni are cooperating agencies for the EA. The following government-to-government tribal consultation, informal tribal consultation, and cooperating agency (CA) meetings were held since 2009:

- Government-to-government tribal consultation meetings were held with the Zuni Tribe at the Pueblo of Zuni at Zuni, New Mexico, on September 15, 2009, March 24, and June 4, 2010;

- Government-to-government tribal consultation meetings were held with the Hopi Tribe (March 4 and April 22 2010, January 27, 2011), Navajo Nation (June 9, 2010, and January 26, 2011), Hualapai (March 6, 2010, and January 8, 2011), Havasupai (March 15, 2010), Kaibab Pauite Tribe (March 18, 2010, and January 20, 2011), and the Paiute Indian Tribe of Utah (December 13, 2010);

- On July 29, 2010, Reclamation participated on a discussion panel about this issue at the 2010 Native American Fish and Wildlife Society Southwest Conference entitled "Non-Native Fish Removal in the Grand Canyon: Cultural Considerations and Fish Management";

- The Assistant Secretary and other representatives from DOI and Reclamation met with the Governor of the Pueblo of Zuni, the Zuni Tribal Council, Zuni Cultural Resource Advisory Team, and the Zuni public at Zuni, New Mexico, to discuss non-native fish removal and the objection of the Zuni people to the killing of rainbow trout on August 5, 2010.

- The Pueblo of Zuni sent Reclamation the Zuni Tribal Council Resolution No. M70-2010-C086 on September 27, 2010, regarding their concerns with mechanical removal and the request that Grand Canyon be included as a TCP eligible for listing on the National Register. This resolution included a signed position statement of the Zuni religious leaders that was given to the Assistant Secretary at the August 5, 2010 meeting.

- A CA and tribal meeting was held in Flagstaff on August 20, 2010.

- CA conference calls were conducted on September 2, 9, 16, 23, 30, and November 4 and 21, 2010, and on January 5, 2011, and March 24, 2011. These often included the

tribes that participated as cooperating agencies, the Pueblo of Zuni and Hualapai Tribe.

- SDM Workshops were conducted on October 18-20, November 8-10, 2010, and representatives from three of the five tribes (the Navajo, Hopi, and Zuni tribes) participated in these.

- Additional tribal consultation meetings with the Pueblo of Zuni were held on January 25, August 30, and December 13, 2011.

Reclamation, along with the USFWS, NPS, BIA, and USGS, is committed to ongoing consultation with these and any other concerned American Indian tribes. Additional meetings will be held with tribes as necessary to define and resolve effects of the proposed action under NHPA section 106.

1.13 *Relevant Resources and Issues*

Reclamation has utilized the scoping results from prior NEPA analyses (e.g. U.S. Department of the Interior 2002), as well as knowledge gained from prior experiments (e.g. Coggins 2008a; Coggins and Yard 2010; Coggins et al. 2011; Gloss et al. 2005; Korman et al. 2010; Makinster et al. 2009b, 2010; Rosi-Marshall et al. 2010; Wright and Kennedy 2011; Yard et al. 2011) to determine the relevant resources and issues for analysis in this environmental assessment. Table 1 presents the list of relevant resources considered for analysis in this EA. Resources in bold were analyzed for effects from the no action and proposed action alternatives. Resources not in bold were considered but not affected by the alternatives.

Table 1. List of resources and issues evaluated.

NATURAL RESOURCES	CULTURAL RESOURCES	SOCIOECONOMIC RESOURCES
Water Resources	**Historic Properties**	Hydropower
Water Quality	**Traditional Cultural Properties**	**Recreation (including Public Safety and Sport Fishing)**
Air Quality		
Sediment		
Vegetation	**Sacred Sites**	
Terrestrial Invertebrates and Herptofauna		
Aquatic Food Base		
Fish • **Humpback chub** • **Razorback sucker** • **Other native fishes** • **Trout** • **Other non-native fishes** • **Fish habitat**		
Birds		
Mammals		

1.14 *Authorizing Actions, Permits or Licenses*

Implementation of the proposed action would require a number of authorizations or permits from various federal and state agencies and American Indian tribal governments. Any field work within the boundaries of GCNP or GCNRA would require permits from the NPS. Tribal permits from the Hualapai Tribe or Navajo Nation would be needed for any field work within reservation boundaries. Researchers working with threatened or endangered species would need to obtain a permit from the USFWS. The proposed action could cause effects to the endangered humpback chub through electrofishing and handling that could require a USFWS ESA section 10(a)(1)(A) permit. Researchers working with resident fish may also need an Arizona Game and Fish Department (AGFD) permit. No other permits are known to be required at this time.

In addition, implementing this action also required additional ESA section 7 consultation with the USFWS. A biological assessment was prepared, along with a supplement to that biological assessment. The USFWS also completed a biological opinion, the 2011 Opinion, on this action. These documents are attached to the EA as Appendix C, D, and E, respectively.

1.15 *Decision Framework*

Reclamation's responsible official must decide whether to implement either the proposed action, an alternative action, or take no action. As the manager of the affected portion of the Colorado River, the NPS would determine whether the proposed action comports with their management plans and policies. The mission of the NPS is to "to conserve the scenery and the natural and historic objects and the wild life therein and…leave them unimpaired for future generations" (1916 NPS Organic Act). The proposed action complies with the overall NPS mission and with NPS Management Policies (National Park Service 2006a, §4.4.4.2) which direct that all exotic (i.e., non-native) species that are not maintained to meet an identified park purpose will be managed—up to and including eradication—if: (1) Control is prudent and feasible; and (2) the non-native species interferes with natural processes and the perpetuation of natural features, native species, or natural habitats. This action is also consistent with the humpback chub recovery goals (U.S. Fish and Wildlife Service 2002a) in which "Brown trout and rainbow trout control programs [shall be] developed and implemented to identify levels of control that will minimize negative interactions on humpback chub in the Colorado River through Grand Canyon."

1.16 *Relationship between EAs for Non-native Fish Control and High-Flow Protocol*

Reclamation has prepared two EAs related to the ongoing implementation of the Glen Canyon Dam Adaptive Management Program. In addition to this EA that addresses non-native fish control, the other EA addresses the development and implementation of a protocol for HFEs from Glen Canyon Dam. Both efforts are designed to include important research components, with the expectation that the undertakings would improve resource conditions, and thereby provide important additional information for future decision-making within the GCDAMP. Although both EAs relate to and are part of the overall GCDAMP, Reclamation has considered the content of both efforts and believes that it is appropriate to maintain separate NEPA processes because each activity under consideration serves a different and independent purpose, has independent utility, and includes very different on the ground activities and actions (rate, duration and timing of water releases as compared with non-native fish research, management and control actions).

The HFE Protocol would evaluate the use of short-duration, high-volume dam releases during sediment-enriched conditions for a 10-year period, 2011–2020, to determine how multiple events can be used to better conserve sand over a long time period in the Colorado River corridor within GCNP. Under the concept of HFEs, sand stored in the river channel is suspended by these dam releases and a portion of the sand is redeposited downstream as sandbars and beaches, while another portion is transported downstream by river flows. These sand features and associated backwater habitats may provide key wildlife habitat, may protect archaeological sites, enhance riparian vegetation, and provide camping opportunities along the Colorado River in GCNP. Additional attention would be given to ensure that other resources would not be unduly or unacceptably impacted or that any such impacts could be sufficiently mitigated.

The Non-native Fish Control EA is designed to further evaluate the control of non-native fish in the Colorado River downstream from Glen Canyon Dam in conserving native fish in GCNP, and is also needed to meet requirements and obligations of several USFWS biological opinions on the operation of Glen Canyon Dam. The proposed action would minimize the negative impacts of competition and predation on an endangered fish, the humpback chub in Grand Canyon. Competition and predation by non-native fishes, and in particular rainbow trout and brown trout, are reducing survival and recruitment of young humpback chub and threatening the potential recovery of the species. The action also addresses the concerns of American Indian tribes over the taking of life associated with non-native fish control.

During the first round of public review and comment on the HFE Protocol and Non-Native Fish Control EAs, several comments from the public suggested that these high-flow dam release and fish control activities are "connected actions" or "similar actions" for NEPA purposes and therefore must be combined into a single NEPA document. The primary basis for this concern appears to be that, notwithstanding the differing nature of the experimental actions, based on a previous high-flow release, there is a concern that high-flow events during certain times of the year have the potential to increase the number of non-native trout that have been documented to feed upon native, endangered humpback chub.

Reclamation reviewed and considered these comments and has added this discussion to this EA in order to provide the public with additional information with respect to the basis for the NEPA processes that are being utilized for the development of these two actions.

As an initial matter, the HFE Protocol and the Non-Native Fish Control efforts are not portions of a single action. The protocol would address multiple projected experimental operations (i.e., variable, high-flow water releases) from Glen Canyon Dam that would link high-volume releases to sediment availability in reaches downstream of Glen Canyon Dam. The high-flow releases would be conducted over a period of years and on multiple occasions to assess the ability to reduce the erosion of beach habitat in the Grand Canyon and potentially to enhance and retain beach habitat over multiple years.

Separately, the non-native fish research and control efforts are designed to enhance understanding of the life-cycle, movement and impacts of non-native fish on the native species in areas of the Colorado River downstream of Glen Canyon Dam. The non-native fish control actions are likely to address methods to reduce the population of predatory non-native trout in areas where young-of-year native fish are located. Predation by non-native fish (both warm water and cold water species) has been identified as a primary threat to native fish in the Colorado River Basin.

Reclamation has considered the most appropriate approach to NEPA compliance for these actions and has reached a conclusion at this stage of analysis that it is not necessary to combine the EAs into a single NEPA document under the applicable NEPA regulations. Under NEPA's implementing regulations, the question of whether the two actions must be analyzed in a single compliance document turns on whether the two actions are considered "connected actions," "cumulative actions," or "similar actions." Pursuant to 40 C.F.R. §

1508.25(a)(1), connected actions are "closely related and therefore should be discussed in the same impact statement." The regulations go on to provide that: "Actions are connected if they: (i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (iii) Are interdependent parts of a larger action and depend on the larger action for their justification." 40 C.F.R. § 1508.25(a)(1).

The EAs do not meet the regulatory standard for connected actions. Neither activity under consideration will automatically trigger other actions which may require environmental impact statements as part of the Glen Canyon Adaptive Management Program. Also, non-native fish control would be necessary regardless of whether or not the HFE Protocol were implemented. Implementation of both the high flow and non-native fish control actions are designed and expected to advance scientific knowledge and inform future GCDAMP decision-making, and may lead to adjustments in release patterns and/or strategies to control the size and location of predatory non-native fish. However, Reclamation cannot conclude at this time that such information will automatically trigger other actions which may require EISs. Secondly, the non-native fish control process is not dependent on other actions being taken previously our simultaneously. Rather, the timing and manner of nonnative fish control will depend, in part, upon the results of monitoring efforts determining the number of trout, their location and movement, etc. While the implementation of spring high-flows has been raised as an issue, given the post-2008 trout monitoring results, it is clear that both warm and cold-water non-native fish control actions may be necessary regardless of high flow implementation. There are no other actions that are conditions precedent to the efforts proceeding, and neither action depends on a larger action for their justification.

There are some obvious relationships and linkages between the two proposed actions, but those similarities do not rise to the standard of requiring preparation of a single NEPA document as "connected actions" for NEPA purposes. Both actions are part of the overall GCDAMP, and they share a common overall geographic area (primarily focused on the mainstem of the Colorado River below Glen Canyon Dam). In addition, there are some overlapping impact analysis issues that are discussed herein, as it is possible that certain high-flow releases may impact the abundance and distribution of nonnative fish that have been identified as species that prey on native fish. However, each action has independent methods (dam releases vs. fish monitoring, tracking, and potential removal actions), an independent focus (geomorphic protection and enhancement of riparian (sandbar) habitat vs. non-native fish research, monitoring and control), and each action has independent utility whether or not the other action proceeds. Moreover, where the two proposed actions are projected to involve overlapping environmental effects (i.e., potential effects on predatory non-native fish species), the relevant analysis of these common environmental effects is included in both EAs.

Another regulatory basis for NEPA documents to be combined is if the activities in question are "similar actions." Pursuant to 40 C.F.R. § 1508.25(a)(3), similar actions "have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography." While the two efforts address areas downstream of Glen Canyon Dam (and thus share a common geography, as well as timing), there are unique

areas that will be the focus of each NEPA effort. The primary action of the high flow protocol is the timing, rate and duration of releases of water from Glen Canyon Dam. In terms of downstream research and monitoring, the HFE Protocol has a particular focus on sediment transport and geomorphological processes, and will include research and monitoring focused on the number, size and distribution of sandbars throughout Marble and Grand Canyons. In contrast, the non-native fish control efforts are focused on biological processes and expected to focus analysis on particular areas that are important to both native and non-native fish species, the PBR and LCR reaches.

Even where two actions are deemed to be "similar actions" under the regulations, the applicable NEPA regulations go on to provide that, "[a]n agency may wish to analyze these actions in the same impact statement . . . when the best way to assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement." 40 CFR § 1508.25(a)(3). This regulatory provision leaves the agency decision makers with sufficient discretion to determine the "best way" to assess impacts of similar actions. Given the differences between the two efforts, and based on the analysis of the differing scientific focus of each experimental effort, Reclamation, based on the best available information that is available at this stage of analysis, has considered this issue and determined that the best way to analyze each action is to continue to analyze the high flow protocol and the non-native fish control strategy through separate and independent NEPA processes, recognizing that resource analyses that are relevant to both EAs have been documented and included in both EAs, where appropriate (e.g., potential high flow impacts on population and distribution of predatory non-native species). Reclamation is also ensuring that both EAs contain up-to-date information on resource status and impacts and has been carefully coordinating the preparation schedules of the two EAs to ensure consistency of content.

Finally, both actions do not constitute "cumulative actions" necessitating review in a single NEPA document as defined by 40 CFR 1508.25 (a)(2). Nonetheless, Reclamation does address the cumulative effects from both actions in the affected environment section of each EA, under the topical discussion for each resource (see Section 3). Thus Reclamation has properly considered the cumulative effects from these two actions and other actions in both NEPA documents. Consistent with these analyses, at this point in the NEPA process Reclamation has not concluded that the actions have "cumulatively significant impacts" which pursuant to 40 C.F.R. § 1508.25(a)(2) would indicate that the actions "should therefore be discussed in the same impact statement."

1.17 *Relationship between this EA and the Long-Term Experimental and Management Plan*

As discussed herein, there are a number of ongoing activities of the GCDAMP that complement the actions and research anticipated under this EA. In addition, the Department is embarking on the first major, comprehensive analysis of the GCDAMP since 1996 with the initiation of the Glen Canyon Dam Adaptive Management Program Long Term Experimental and Management Plan (LTEMP; 76 FR 39435-46, July 6, 2011). The Department has determined that it is appropriate and timely to undertake a new

environmental impact statement (EIS) that reviews and analyzes a broad scope of Glen Canyon Dam operations and other related activities. Given that it has been 15 years since completion of the 1996 ROD on the operation of Glen Canyon Dam, the Department will study new information developed through the GCDAMP, including developed through the non-native fish control addressed in this EA, as well as information on climate change, so as to more fully inform future decisions regarding the operation of Glen Canyon Dam and other management and experimental actions. The LTEMP is a component of the Department's efforts to continue to comply with the ongoing requirements and obligations established by the Grand Canyon Protection Act of 1992 (Pub. L. No. 102-575). The Department has determined that the LTEMP EIS will be co-led by the Bureau of Reclamation and the National Park Service. Reclamation and the NPS will co-lead this effort because Reclamation has primary responsibility for operation of Glen Canyon Dam and the NPS has primary responsibility for GCNP and GCNRA. A formal notice of intent to prepare an EIS was published in the Federal Register on July 5, 2011 (76 FR 39435), and a notice to solicit comments and hold public scoping meetings on the LTEMP was published in the Federal Register on October 17, 2011 (76 FR 64104).

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 Endangered Species Act (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. Accordingly, Reclamation has determined that it is essential and appropriate to move forward with this EA because it will provide important information related to non-native fish control. This information is important for independent reasons described throughout this EA, and it will also aid in future decisions associated with the LTEMP process. Such information on the predation and migration patterns of non-native fish would not be available absent implementation of the non-native fish control actions described herein. Continuing with the EA to learn more information about Glen Canyon Dam operations is consistent with the principles of adaptive management, which have guided decision making since the 1996 ROD.

1.18 *Issues for Analysis*

NEPA requires that any issues directly or indirectly caused by implementing the proposed action be analyzed. The Council on Environmental Quality (CEQ) NEPA regulations in 40 CFR 1501.7 allow that issues may be excluded from analysis if they are identified as those: (1) Outside the scope of the proposed action; (2) already decided by law, regulation, plan; (3) irrelevant to the decision to be made; or (4) conjectural and not supported by scientific or factual evidence. Relevant issues must be analyzed to determine the effects of potential

actions to resources of concern, and thereby select an alternative that best meets the purpose and need.

The relevant issues to the proposed action were identified through the NEPA process, including through the SDM Project with the cooperating agencies and tribes, and these issues were used in this EA as criteria for selection of the proposed action. In the SDM Project, the "issues" described in this section led to a definition of "objectives" of the undertaking, against which various actions were compared for their ability to achieve the objectives (see Appendix A, Section 4.3). This process revealed that the primary issues surrounding non-native fish control in Grand Canyon deal with effects to natural resources, impacts to recreation, and cultural and socioeconomic concerns. These issues were carefully analyzed in the SDM Project and in this EA to help formulate and evaluate alternatives and identify the proposed action.

The proposed action is designed to benefit native and endangered fish with the acknowledgement that there may be unintended side effects to this beneficial action. These issues capture what those unintended side effects may be, and were further analyzed in the SDM Project and in other sections of this EA.

Issue 1: American Indian Concerns with the Taking of Life

Beginning with tribal consultation on the first experimental non-native fish removal efforts in 2002, several southwestern tribes (The Hopi Tribe, the Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, the Hualapai Tribe, and the Zuni Tribe) objected to the taking of life at the confluence of the Colorado and Little Colorado rivers. To mitigate these concerns, the action agencies (USGS, NPS, and Reclamation) and the concerned tribes agreed that fish removed from the LCR reach during 2003-2006 and 2009 would be put to a beneficial use. The beneficial use consisted of euthanizing removed fish, which were then ground to an emulsion, packaged in 50-gallon barrels on site in the Grand Canyon, and transported to the Hualapai Tribe where they were used as fertilizer for organic vegetable farms on Hualapai tribal lands.

Since 2006, the rainbow trout population has undergone an increase in the LCR reach (Wright and Kennedy 2011). In response to increasing trout numbers, and as part of the conservation measure to control non-native fish in the 2008 USFWS Biological Opinion, Reclamation, through the GCDAMP, conducted a single non-native fish removal trip in the LCR Reach to better determine levels of trout abundance in the LCR reach and refine the level of removal necessary to meet as yet undefined goals for trout suppression. The Pueblo of Zuni subsequently expressed concern over the taking of life in the Colorado River from this action, and later the other GCDAMP tribes all indicated some level of concern about this aspect of non-native fish control. The Navajo and Hopi tribes also expressed concerns about the geographic location of non-native removal in the LCR reach, which is an important traditional cultural place for these tribes.

The Pueblo of Zuni has expressed concern over both the action of removing and euthanizing fish and the location of where that action takes place. The Zuni place traditional and

historical importance on the Grand Canyon and the confluence of the Little Colorado River and Colorado River. The Zuni have stated that it is not only the taking of life that concerns the Zuni people, but also the adverse affect this action has on the Zuni values that are ascribed to the Grand Canyon, the Colorado River, and the confluence of the LCR and Colorado Rivers as a National Register-eligible traditional cultural property.
The GCDAMP tribes and other stakeholders have expressed skepticism in the premise that removing rainbow trout and non-native predatory fish actually benefits humpback chub. This is because, as discussed above, although humpback chub status improved during the period of non-native fish removal from 2003-2006, other factors may have been responsible for this improvement (Yard et al. 2011, Coggins et al 2011). The 2003-2006 removal efforts successfully reduced numbers of rainbow trout in the LCR reach from approximately 6,446 to 617, and during this period humpback chub recruitment continued to increase and the adult humpback population in the LCR increased from approximately 5,000 to 7,650 (Coggins and Walters 2009; Coggins et al. 2011). However, as discussed previously, rainbow trout were also undergoing a decline system-wide during this period, possibly due to lower flows and warmer water temperatures, conditions which also may have benefitted humpback chub. And although there is compelling evidence that rainbow trout can consume large numbers of young humpback chub, a causal link between non-native trout predation on humpback chub and adult abundance of humpback chub has not been established (Yard et al. 2011).

This issue was considered in the SDM Project. The SDM Project identified cultural concerns as a fundamental objective (see Appendix A, Section 4.3), and different non-native fish control actions were evaluated, in part, on their performance in minimizing adverse effects to the tribal concerns. The proposed action is further analyzed here in comparison with no action with regard to effects to cultural resources and in light of cultural concerns in Section 3, Affected Environment and Environmental Consequences. A criticism of some tribes has been that the SDM Project did not place sufficient emphasis on learning to address the uncertainties in the need to conduct removal to conserve humpback chub. Measures to address these concerns are incorporated into the proposed action as described in sections 1.10 and 2.3 of this EA.

Issue 2: Efficacy of Alternative Means of Controlling Non-native fish and Effects on Other Aquatic Life

Several methods have been used to control non-native fish in the Colorado River below Glen Canyon Dam, including:

- Removal of trout with boat electrofishing in the LCR reach;
- Low flows to strand rainbow trout eggs and young (“non-native fish suppression flows”);
- Removal of brown and rainbow trout from Bright Angel Creek with a fish weir (this action is both a past and ongoing action by the NPS).

The most effective single method of reducing non-native fish numbers has been removal of fish using boat-mounted electrofishing in the LCR reach. This method directly removes non-native fish, predominantly rainbow trout, from the area of greatest impact to humpback chub and was effective at reducing numbers of trout during 2003-2006 (Coggins et al. 2011), and this action also appeared to substantially reduce predation losses of humpback chub (Yard et al.2011). However the method was applied at a time of system-wide trout decline (Coggins et al. 2011) and the numbers of rainbow trout in the LCR reach recovered to former levels by 2009. Although about 20,000 trout were removed from the LCR reach from 2003-2006 (Coggins, 2008a; Coggins and Yard 2010; Yard et al. 2011), the large 2008 rainbow trout cohort spawned in Lees Ferry, apparently as a result of the 2008 HFE (Korman et al. 2010), is thought to have led to downriver migration of this cohort, and, combined with local recruitment along downriver sections, contributed to an increase in rainbow trout densities in the vicinity of the Little Colorado River since 2006 (Makinster et al. 2010, Wright and Kennedy 2011). This recovery made it clear that in order to reduce trout abundance in the LCR reach numbers of trout moving into the area would have to be controlled on a routine basis or reduced at their sources, at or near the Lees Ferry reach for rainbow trout, and in Bright Angel Creek for brown trout.

There are a number of other alternative means, including many that have not been tested in this system but have worked in other regulated rivers when applied appropriately. One mechanism that has been tested in the action area and may be effective at controlling non-native fish involves manipulating flows at Glen Canyon Dam to suppress the rainbow trout population at its primary source in Lees Ferry. There is clear evidence that this method can work because unrestrained fluctuating flows of approximately 3,000 to 30,000 cfs from Glen Canyon Dam before the implementation of interim/modified low fluctuating flows in 1991 eliminated almost all natural reproduction of rainbow trout in Lees Ferry, to the point that the fishery was not self-sustaining, but also had adverse effects to native fishes and other resources, leading to the 1995 EIS and 1996 ROD selection of MLFF as an alternative flow operation. To attempt to mimic this effect, fluctuations of from 5,000 to 20,000 cfs were tested from 2003-2005 ("non-native fish suppression flows"). These flows were effective in reducing survival of young trout, but density-dependent factors compensated with higher survival and growth of the remaining fish (Korman et al. 2005), thus the flows were not effective at limiting trout recruitment.

Evaluating the effect of non-native fish control on humpback chub is difficult because losses to fish predation are just one source of humpback chub mortality. Other sources of mortality include starvation, stranding, cold-water shock, parasites and diseases, and downstream transport from the LCR reach to less suitable habitat (Berry and Pimentel 1985; Hoffnagle et al. 2006; Korman et al. 2006; Marsh and Douglas 1997; Robinson et al. 1998; U.S. Fish and Wildlife Service 2002a; Ward and Bonar 2003). It is difficult to isolate the effect of any single mortality source and evaluate its effect on the overall population. Different sources of mortality may have a stronger effect at some times than others, and often the degree of effect from a single source may interact with other sources or environmental factors in complex ways.

Although the population of adult humpback chub (age 4 and >200 mm total length) declined from 1989 to 2001, the adult population of humpback chub has been increasing since 2001 (Figure 3). Because these estimates include fish that are 4 years of age and older, survival of fish that contributed to the population increase after 2001 was affected by factors starting in about 1998 (Coggins and Walters 2009). Although this increase began at the peak of trout density in the Lees Ferry reach, the subsequent increase in the humpback chub population is a pattern opposite that of the declining trout population, and suggests an effect from reduced trout density (Wright and Kennedy 2011). The sudden increase in the trout population in 2008 is attributed, at least in part, to the spring 2008 high flow experiment and the effect of this increase on humpback chub survival and recruitment has not been evaluated.

Tribes and members of the public expressed concerns about the effect of elements of potential actions (particularly the use of electrofishing) on invertebrates or other aquatic species. Electrofishing is used widely for sampling fish populations (Snyder 2003), and in some cases there is increased drift of invertebrates resulting from electrofishing, but in most cases there have been no long-lasting or fatal effects reported on macroinvertebrates (Elliott and Bagenal 1972; Fowles 1975; Mesick and Tash 1980); the only case where electrofishing produced mortality of macroinvertebrates (30% mortality of the midge species *Chironomus plumosa*) was in cases where voltages were 15-126 times the maximum levels normally used for sampling fish (Shentyakova et al. 1970). Although there has been no effort to specifically study the effect of electrofishing on macroinvertebrates or other non-target aquatic species, biologists involved in electrofishing in Grand Canyon have not reported any noticeable effect on these species, and it has not been considered by researchers to be an issue of concern.

These issues where analyzed in detail in the SDM Project, which evaluated the performance of different methods of non-native fish control. The proposed action is further analyzed in comparison with no action with regard to effects to the aquatic ecosystem in Section 3, Affected Environment and Environmental Consequences.

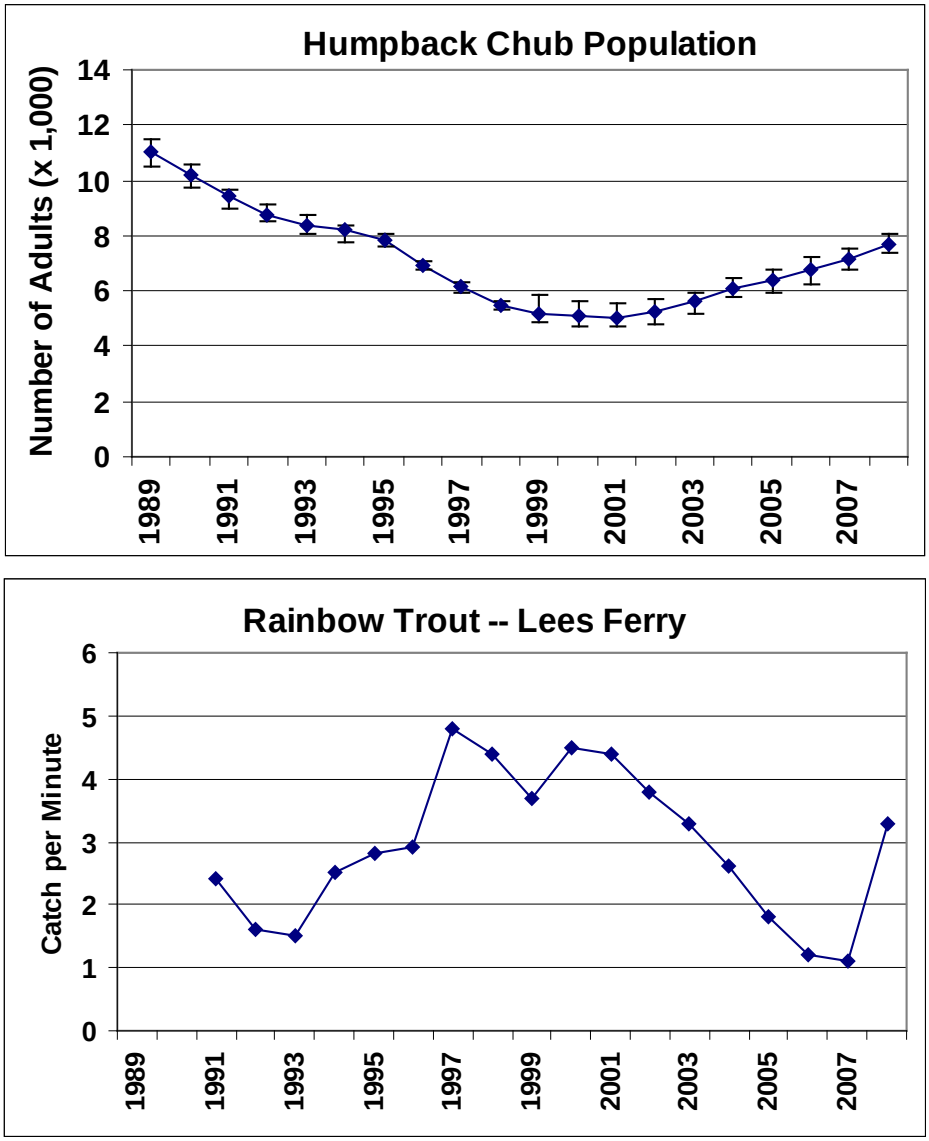

Figure 3. (Top) Annual population estimates of adult humpback chub (age 4+) with an age-structured mark-recapture (ASMR) model, 1989-2008 (Coggins and Walters 2009) (Bottom) Average annual catch rates of rainbow trout in the Lees Ferry reach, 1991-2008 (Makinster et al. 2010)

Issue 3: Diminished Sport Fish Angling Opportunities

Controlling numbers of trout in Grand Canyon has the potential to affect visitors who come to the parks for recreation. Because the actions analyzed here directly affect fish populations, there would be effects to sport fishing, potentially as reduced opportunity for sport fishing in the action area. If non-native fish control were to affect the Lees Ferry trout population, there would also be a potential impact to fishing guides whose livelihoods derive from providing guide services for anglers in the Lees Ferry reach. Reducing the numbers of rainbow trout in the Lees Ferry reach could affect angler catch rates, depending on the number of anglers and the density of trout in areas fished. Adverse impacts to recreational angling and subsistence fishing by local American Indian residents is also an aspect of this issue.

Reducing the numbers of trout in the system could also provide a beneficial effect to the sport fishery in the action area by improving the quality of the fishery. Reducing numbers of rainbow trout in the system, particularly when densities are high, could improve the fishery by providing more space for fish, reducing competition for available food resources, reducing emigration, and possibly increasing growth rate, and size and condition of individual fish. It is possible that reduction of the overall abundance of trout in the Lees Ferry reach would not affect catch rate if current trout density is high and competition is high for a limited food supply. The existing data appear to indicate that rainbow trout are leaving the Lees Ferry reach and moving downstream, presumably as a density-dependent response to high numbers, which may indicate an over-abundance of trout in Lees Ferry (Korman et al. 2010; Wright and Kennedy 2011).

This issue was identified as an objective in the SDM Project (see Appendix A, Section 4.3), and different actions were evaluated, in part, on their performance in minimizing adverse effects to recreational trout fishing, and thereby utilized to select the proposed action. The proposed action is further analyzed here in comparison with no action with regard to effects to recreation, in Section 3, Affected Environment and Environmental Consequences.

Issue 4: Effects to Wilderness

Pursuant to the 1964 Wilderness Act, Grand Canyon National Park was evaluated for wilderness suitability. After the park was enlarged in 1975, Grand Canyon's Wilderness Recommendation was updated following a study of the new park lands. The most recent update of Grand Canyon's Wilderness Recommendation occurred in 2010. Grand Canyon National Park proposed Wilderness or proposed potential Wilderness covers 94 percent of the park. In accordance with NPS Management Policies, these areas are managed in the same manner as designated wilderness, and the NPS will take no action to diminish wilderness suitability while awaiting the legislative process.

The proposed action would implement up to 10 PBR reach trips in any one year, and up to 6 LCR reach trips in any one year; LCR reach removal would only occur 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). Motorized electrofishing boats would operate at night, utilizing lights and gas-generators to power electrofishing equipment. Removal trips would have up to 6 passes of electrofishing boats through a reach per trip, and this would take place over multiple nights as described in more detail in the "Effects of the Proposed Action" section. Recreationists seek the GCNRA and GCNP out, in part, due to the wilderness character of these remote areas. The proposed action would result in disturbance to members of the public utilizing these areas for recreation. These impacts would be further assessed and mitigated through the NPS Minimum Requirement Analysis.

The NPS is mandated under the Organic Act of 1916 "to conserve the scenery and the natural and historic objects and the wild life therein and…leave them unimpaired for future generations" (1916 NPS Organic Act). In accordance with this mandate and the NPS Management Policies (National Park Service 2006a, §4.4.4.2), all exotic (i.e., non-native) species must meet an identified park purpose or be controlled or eradicated. Rainbow trout

and brown trout in the vicinity of the Colorado and Little Colorado rivers compete with and prey on humpback chub and threaten the recovery of the species. Hence, control of non-native fish within GCNRA and GCNP is consistent with the mission and mandates of the NPS, as well as compliance by the DOI and its agencies under the provision of the ESA, and adds to the wilderness quality of the park in a manner that is consistent with NPS management policies.

These issues were identified as an objective in the SDM Project (see Appendix A, Section 4.3), and different actions were evaluated, in part, on their performance in minimizing adverse effects to wilderness recreation, and thereby utilized to select the proposed action. The proposed action is further analyzed here in comparison with no action with regard to effects to recreation, in Section 3, Affected Environment and Environmental Consequences.

Issue 5: Diminished Public Services and Losses to Local Economies

Recreation in GCNRA and GCNP provides economic benefits to local economies, particularly in the areas of Vermilion Cliffs and Marble Canyon, Page, and Flagstaff, Arizona, and Kanab and surrounding areas of southern Utah. These economic and social benefits are to both small rural communities and to the region. A number of businesses (lodges, restaurants, guides, outfitters, and others) and individuals derive their income from recreationists who have come to the area to fish, hike, or engage in white water rafting. Economic benefits are associated with factors such as the number of days anglers visit the area, and the number of white water rafting trips that occur in a given year.

A key aspect of economic benefits from visitation to the area is associated with wilderness and park experiences. GCNP provides benefits to both local and regional economies. Non-native fish control could affect the experience of the public who come to the area for wilderness recreation through the additional activities associated with the removals, particularly motorized and night-time operations within proposed wilderness that cause disturbance.

The cost of non-native fish control is also an issue because the GCDAMP and Reclamation have limited annual budgets with which to carry out non-native fish control actions. In the past, non-native fish control efforts have utilized flows from Glen Canyon Dam as well as electrofishing at the confluence of the Colorado and Little Colorado Rivers to limit numbers of non-native fishes, particularly rainbow and brown trout. Past control efforts have been costly and GCDAMP stakeholders are interested in finding effective means of non-native fish control that are economically viable.

Any alternative considered for non-native fish control must be consistent with maintaining required water storage and delivery per the Colorado River Storage Project (CRSP). The CRSP and the Colorado River are managed and operated under numerous compacts, federal laws, court decisions and decrees, contracts, and regulatory guidelines collectively known as the "Law of the River." This collection of documents apportions the water and regulates the use and management of the Colorado River among the seven basin states and Mexico. Glen

Canyon Dam is also operated to be in compliance with the 2007 Colorado River Interim Guidelines.

A key public service provided by Glen Canyon Dam is electricity generation. The electricity produced at Glen Canyon Dam through hydropower is a renewable and environmentally preferred resource. It is integrated into the electrical production of several large Colorado River Storage Project Dams and it serves part of the needs of over five million people, in the rural Rocky Mountain and desert Southwest. It also provides a large portion of the electrical needs of American Indian communities in the southwest. It is sold as a long-term firm product, at the cost of production, under terms that allow flexibility so as to schedule electrical power deliveries to maximize the value of the Glen Canyon Dam power resource.

These issues were thoroughly evaluated in the SDM Project (see Appendix A, Section 4.3) by assessing alternatives, in part, on their performance in minimizing adverse effects to these resources, and thereby used to select the proposed action. The proposed action is further analyzed here in comparison with no action with regard to effects to recreation, in Section 3, Affected Environment and Environmental Consequences.

Issue 6: Constraints Imposed by Reclamation's Authority and Operational and Legal Requirements

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).

Alternatives must also meet Reclamation's responsibilities with regard to operation and maintenance of the dam, as well as meeting scheduled downstream deliveries of water. Potential actions were evaluated in this regard in the SDM Project and this contributed to the selection of the proposed action.

Reclamation also has a responsibility to recognize Indian Trust Assets and maintain compliance with section 106 of the National Historic Preservation Act (NHPA), which is part of the need for this EA. The Federal government holds Trust responsibilities that recognize the sovereign status and management authority of Tribes, and assures the Tribes that Federal agencies will not knowingly compromise traditional practice and livelihoods in execution of their duties. Executive Order 13007 adds specificity to this principal in stating that Federal agencies "shall avoid adversely affecting the physical integrity of sacred sites," while Secretarial Order 3206 stipulates that within the context of the ESA the "Departments will carry out their responsibilities under the Act in a manner that harmonizes the Federal trust responsibility to tribes." Further, the NHPA requires Federal agencies to take into account the effects of their actions on historic properties, which, through the National Register of Historic Places, includes special provisions for places of cultural and religious importance.

These issues were identified in the SDM Project (see Appendix A, section 4.3), and different alternatives were evaluated, in part, on their performance in minimizing adverse effects to Reclamation's operational and legal responsibilities, and thereby used to select the proposed action. The proposed action is further analyzed here in comparison with no action with regard to effects to cultural resources, in Section 3, Affected Environment and Environmental Consequences.

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 electrofisihing. 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 or 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.

3.0 Affected Environment and Environmental Consequences

This section describes the potential changes to the environment due to implementation of the alternatives. It presents the scientific and analytical basis for comparison of alternatives. Resource analysis includes a consideration of direct, indirect, and cumulative impacts in accordance with CEQ and Interior regulations. Each impact topic or issue is analyzed for direct, indirect, or cumulative effects from each of the alternatives, and in consideration of related actions, projects, plans, and documents (Section 1.7). Impacts are described in terms of context (site specific, local or regional), duration (short- or long-term), timing (direct or indirect), and type (adverse or beneficial). Issues related to natural resources are described first, followed by socioeconomic and cultural resources. Any cumulative effects that may be present are discussed in their respective resource areas and not in a stand-alone cumulative effects section. There are relatively few actions that cumulatively impact the affected environment because the location of the proposed action is the Colorado River in Glen, Marble, and Grand Canyons, almost entirely in national parks, GCNP and GCNRA, areas protected and managed for their natural resources and scenic beauty and thus not likely to be subject to many project impacts.

3.1 *General Setting*

The action area or geographic scope of this environmental assessment is a 294-mile reach of the Colorado River corridor from Glen Canyon Dam downstream to the Lake Mead inflow near Pearce Ferry (Figure 1). Glen Canyon Dam impounds the Colorado River about 16 miles upstream from Lees Ferry, Coconino County, Arizona. This action area includes GCNRA in a 16-mile reach from Glen Canyon Dam to the Paria River; and GCNP, a 277-mile reach from the Paria River downstream from Lees Ferry to the Grand Wash Cliffs near Pearce Ferry. In terms of geomorphic features, Glen Canyon encompasses a 16-mile reach from the dam to the Paria River; Marble Canyon is a 61-mile reach from the Paria River to the LCR; and Grand Canyon is a 217-mile reach from the LCR to near Pearce Ferry. The Glen Canyon segment of the action area is also commonly referred to as the Lees Ferry reach. Additional description of the action area and its associated resources can be found in Gloss et al. (2005).

3.2 *Natural Resources*

Natural resources are those physical, chemical, and biological components of the action area that individually and collectively comprise the ecosystem and contribute to the values of GCNP and GCNRA. These typically include water resources, water quality, air quality, sediment, vegetation, terrestrial invertebrates and herptofauna, aquatic food base, fish, birds, and mammals. Based on a review of all natural resources in the action area, only those resources likely to be directly, indirectly, or cumulatively affected by the proposed action are

described herein. Of the natural resources, the alternatives considered in this EA would only have effects to fish, so the other resources are not considered further.

3.2.1 *Fish*

Altogether, 20 species of fish occur in Grand Canyon, including 15 non-native (Table 2) and five native species. Five of the eight fish species native to the Colorado River in Grand Canyon have persisted, including humpback chub, flannelmouth sucker, bluehead sucker, and speckled dace (Valdez and Carothers 1998). The razorback sucker is extirpated from Grand Canyon, but is found as a small reproducing population downstream from the canyon, in and below the Colorado River inflow to Lake Mead (Abate et al. 2002, Albrecht and Holden 2006).

Table 2. Non-native fish species presently found in the Colorado River and lower end of tributaries from Glen Canyon Dam to near Pearce Ferry (Ackerman 2008).
0 = absent, R = rare, L = locally common, N = numerous, A = abundant.

Common Name	Scientific Name	Lees Ferry	Marble Canyon	Grand Canyon
Black bullhead	*Ameiurus melas*	0	R	L
Brown trout	*Salmo trutta*	R	R	L
Largemouth bass	*Micropterus salmoides*	0	0	R
Mosquitofish	*Gambusia affinis*	0	0	L
Red shiner	*Cyprinella lutrensis*	0	0	L
Channel catfish	*Ictalurus punctatus*	0	R	N
Common carp	*Cyprinus carpio*	L	N	N
Fathead minnow	*Pimephales promelas*	0	0	L
Green sunfish	*Lepomus cyanellus*	0	0	R
Plains killifish	*Fundulus zebrinus*	0	0	L
Rainbow trout	*Oncorhynchus mykiss*	A	A	L
Redside shiner	*Richardsonius balteatus*	R	R	R
Smallmouth bass	*Micropterus dolomieu*	R	R	R
Striped bass	*Morone saxatilis*	R	R	R

Walleye	*Sander vitreus*	R	R	R

3.2.1.1 Humpback Chub

The humpback chub is currently listed as endangered under the ESA. The humpback chub recovery plan was approved on September 19, 1990 (U.S. Fish and Wildlife Service 1990), and recovery goals were developed in 2002 (U.S. Fish and Wildlife Service 2002a). The recovery goals were set aside as a result of litigation and are in the process of being revised by the USFWS. Designated critical habitat exists in two reaches near the action area (U.S. Fish and Wildlife Service 1994); the lower 8 miles of the LCR and 173 miles of the Colorado River and its 100-year floodplain in Marble and Grand Canyons from Nautiloid Canyon (RM 34) to Granite Park (RM 208). There are six extant populations, five in the upper Colorado River Basin and one in the lower Colorado River Basin. The largest of these populations is the Grand Canyon population, the population that occurs in the action area. The Grand Canyon population consists of nine aggregations, with most individuals in and near the LCR (Valdez and Ryel 1995). Although there is evidence that the humpback chub spawns in other aggregations, the species spawns primarily in the LCR, although young are also found in the Fence Fault Warm Springs at RM 30 (Valdez and Masslich 1999) and further downstream in Middle Granite Gorge. Juvenile humpback chub occur downstream from Glen Canyon Dam at most aggregations (Figure 2), but it is uncertain if these fish originated from the LCR or from local reproduction.

Young and juvenile humpback chub are found primarily in the LCR and the Colorado River near the LCR confluence, although many are found upstream of the LCR, presumably from spawning near the Fence Fault Warm Springs (Valdez and Masslich 1999; Anderson et al. 2010). Humpback chub reproduction occurs annually in spring in the LCR and the young fish either remain in the LCR or disperse downstream into the Colorado River. Dispersal of these young fish has been documented as nighttime larval drift during May through July (Robinson et al. 1998), as density dependent movement during strong year classes (Gorman 1994), and as movement with summer floods caused by monsoonal rain storms during July through September (Valdez and Ryel 1995). Survival of these young fish in the mainstem is thought to be low because of cold mainstem water temperatures (Clarkson and Childs 2000; Robinson and Childs 2001), but fish that survive and return to the LCR contribute to recruitment in this population. Predation by rainbow trout and brown trout in the LCR confluence area has been identified as an additional source of mortality affecting survival and recruitment of humpback chub (Valdez and Ryel 1995; Marsh and Douglas 1997; Yard et al. 2011).

Population estimates using an age-structured, mark-recapture (ASMR) method show that the population has ranged from about 11,000 adults (4 years old and older and capable of reproduction) in 1989 to 5,000 adults in 2001 (Coggins and Walters 2009). The number of adults decreased from 1989 to 2001, but increased by approximately 50 percent between 2001 and 2008 to an estimated 7,650 adults (Figure 4). Inter-relationships between river flow and humpback chub habitat show a close association of juveniles (less than 4 years old and 200 mm total length) with certain reaches of river having shoreline cover, including large rock talus, debris fans, and vegetation (Converse et al. 1998). Adults also show an affinity for the same river reaches and generally remain in low-velocity pockets within large

recirculating eddies (Valdez and Ryel 1995). The principal area occupied by the Grand Canyon population of humpback chub is in and around the LCR, about 77 mi (123 km) downstream from the dam.

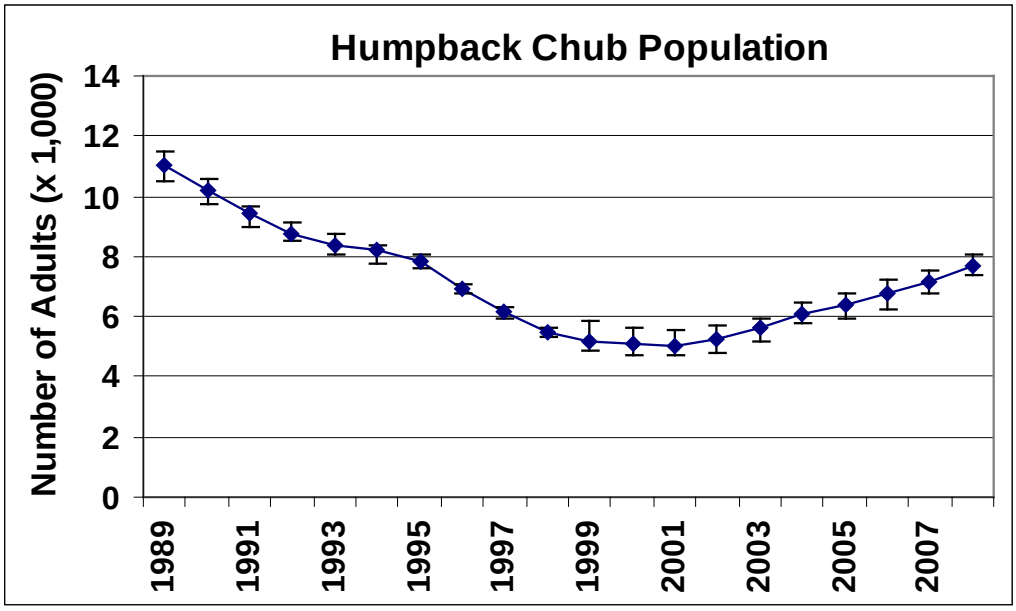

Figure 4. Estimated adult humpback chub abundance (age 4+) from ASMR, incorporating uncertainty in assignment of age. Point estimates are mean values among 1,000 Monte Carlo trials, and error bars represent maximum and minimum 95-percent profile confidence intervals among 1,000 Monte Carlo trials. All runs assume the coefficient of variation of the von Bertalanffy L∞ was CV (L∞) = 0.1 and adult mortality was M∞ = 0.13 (Coggins and Walters 2009).

3.2.1.2 Razorback Sucker

The razorback sucker is currently listed as "endangered" under the ESA (56 FR 54957). Designated critical habitat includes the Colorado River and its 100-year floodplain from the confluence with the Paria River (RM 1) downstream to Hoover Dam, a distance of nearly 500 miles, including Lake Mead to the full pool elevation. A recovery plan was approved on December 23, 1998 (U.S. Fish and Wildlife Service 1998) and recovery goals were approved on August 1, 2002 (U.S. Fish and Wildlife Service 2002b). Primary threats to razorback sucker populations are streamflow regulation and habitat modification and fragmentation (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by non-native fish species; and pesticides and pollutants (Bestgen 1990; Minckley 1991).

The razorback sucker has not been reported in Grand Canyon since 1990 and only 10 adults were reported between 1944 and 1995 (Gloss et al. 2005). Carothers and Minckley (1981) reported four adults from the Paria River in 1978-1979. Maddux et al. (1987) reported one female razorback sucker at Upper Bass Camp (RM 107.5) in 1984, and Minckley (1991) reported five adults in the lower LCR from 1989-1990. The razorback sucker is probably extirpated from the Colorado River and its tributaries between Glen Canyon Dam and the Lake Mead inflow, although a small reproducing population occurs in Lake Mead (Albrecht and Holden 2006).

3.2.1.3 Non-Listed Native Fishes

The Colorado River from the Glen Canyon Dam to the Paria River supports small numbers of bluehead sucker, flannelmouth sucker, and speckled dace. Flannelmouth sucker spawn in this reach and in the lower Paria River (McIvor and Thieme 2000; McKinney et al. 1999; Thieme 1998). Bluehead sucker, flannelmouth sucker, humpback chub, and speckled dace occur in moderate numbers in the river between the Paria and Little Colorado rivers (Ackerman 2008; Lauretta and Serrato 2006; Johnstone and Lauretta 2007; Trammell et al. 2002;). Most native fish in the mainstem from the dam to the LCR are large juveniles and adults. Earlier life stages rely extensively on more protected nearshore habitats, primarily backwaters (Lauretta and Serrato 2006; Trammell et al. 2002). The 174 miles from the LCR to Bridge Canyon has six large tributaries and supports a diverse fish fauna of cool- to warm-water species to about Havasu Creek, including the three non-listed native species. Non-listed native fish are also well represented in Bright Angel, Shinumo, Tapeats, Kanab, and Havasu creeks (Johnstone and Lauretta 2007; Leibfried et al. 2006), especially during spawning periods.

The Grand Canyon fish community shifted over the past decade from one dominated by non-native salmonids to one dominated by native species (Ackerman 2008; Johnstone and Lauretta 2007; Lauretta and Serrato 2006; Makinster et al. 2010; Trammell et al. 2002). Catch rates of flannelmouth and bluehead suckers increased four to six-fold from 2000 through 2008, and speckled dace catch rates were steady but generally higher than historical levels (Johnstone and Lauretta 2007; Lauretta and Serrato 2006; Makinster et al. 2010). It is hypothesized that recent shifts from non-native to native fish are due in part to warmer than average water temperatures and declines of coldwater salmonids (Ackerman 2008; Andersen 2009). Despite the fact that the warmer water temperatures have somewhat dissipated and non-native fish numbers, especially trout, have dramatically increased, the high abundance of native fish has persisted.

3.2.1.4 Trout

Two species of non-native trout are found in Grand Canyon, the rainbow trout and brown trout. The population of rainbow trout in the 15-mile long Lees Ferry tailwater reach has undergone large changes in abundance since standardized monitoring began in 1991. Recruitment and population size appear to be governed largely by dam operations (Arizona Game and Fish Department, 1996; McKinney et al. 1999, 2001; Wright and Kennedy 2011). Rainbow trout are also found fairly consistently in the mainstem Colorado River between the Paria River and the LCR confluence (Makinster et al. 2010). Below that point, small numbers are found associated with tributaries, including Bright Angel Creek, Shinumo Creek, Deer Creek, Tapeats Creek, Kanab Creek, and Havasu Creek. Brown trout are found primarily near and in Bright Angel Creek, where there is a spawning population. Small numbers are found elsewhere in the canyon.

The rainbow trout population in the Lees Ferry reach has been monitored since 1991. From 1993 to 1997, the population increased and remained high until 2001 (Figure 5). McKinney et al (1999) attributed the dramatic increase from 1991 to 1997 to increased minimum flows and reduced daily discharge fluctuations. After 2001, there was a steady decline in the Lees Ferry population until 2007. A similar decline in rainbow trout abundance below the Paria River was observed during that same time period (Makinster et al. 2010). The 2001–2007

decline is attributed to increased water temperatures (associated with low reservoir elevations) and trout metabolic demands coupled with a static or declining food base, periodic oxygen deficiencies and nuisance aquatic invertebrates (New Zealand mudsnails; Behn et al. 2010). Concurrent with these declines in abundance, however, trout condition (a measure of plumpness or optimal proportionality of weight to fish length) has increased, reflecting a strongly density dependent fish population where growth and condition are inversely related to fish abundance (McKinney et al. 1999, 2001).

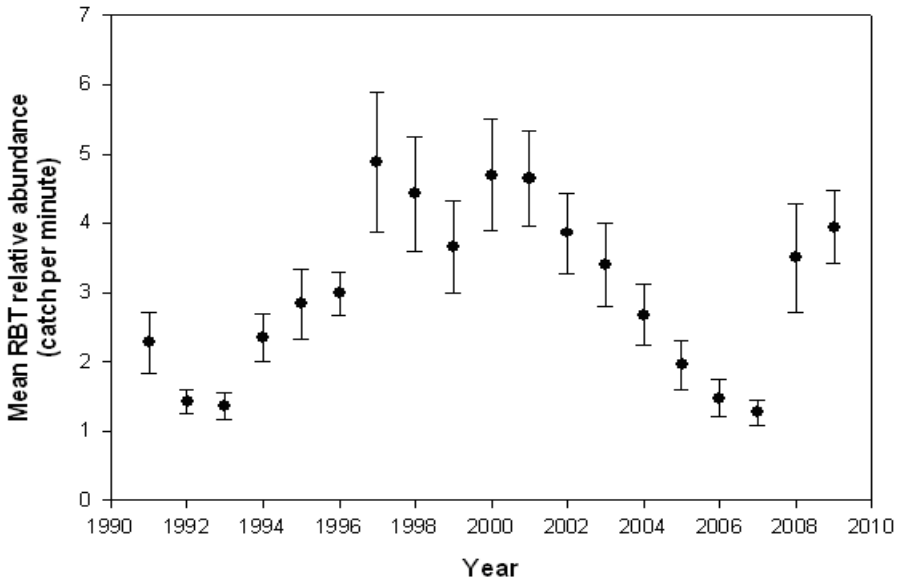

Figure 5. Average annual electrofishing catch rates of rainbow trout in the Lees Ferry reach (Glen Canyon Dam to Lees Ferry) for 1991-2010 (Makinster et al. 2010).

During 2003-2005, "nonnative fish suppression flows" were released from the dam to evaluate these flows in controlling the trout population in the Lees Ferry reach with high and low flows to reduce survival of eggs and young. In addition, a program of mechanical removal was conducted in the vicinity of the LCR during 2003–2006 and 2009 to determine if electrofishing could be used to control trout and minimize competition and predation on humpback chub in that reach. Although the "non-native fish suppression flows" did result in a total redd loss estimate of 23% in 2003 and 33% in 2004, this increased mortality did not lead to reductions in overall recruitment due to increases in survival of rainbow trout at later life stages (Korman et al. 2005; Korman et al. 2011). Removal of non-native fish using boat-mounted electrofishing in the LCR reach was effective for both rainbow trout and brown trout removal. Of 36,500 fish captured from 2003-2006, 23,266 were non-native, including 19,020 rainbow trout and 470 brown trout. Levels of both trout species were effectively suppressed in the LCR reach using this method, especially rainbow trout, which dropped from an initial estimated abundance of 6,466 in January of 2003 to a low of 617 in February 2006 (Coggins et al. 2011). An increase in rainbow trout in the LCR reach since 2006 has been attributed to the increased survival and growth of young trout following the March 2008 HFE (Wright and Kennedy 2011). The 2008 HFE likely benefitted rainbow trout by flushing fine sediment from spawning gravels, thus improving survivorship of young trout, and also appears to have resulted in an increase in available food for trout (Korman et al. 2010; Rosi-Marshall et al. 2010). An even larger increase in trout appears to have occurred in 2011,

likely as a result of high steady flow releases under the 2007 Colorado River Interim Guidelines (J. Korman, Ecometric, pers. comm., 2011).

3.2.1.5 Other Non-Native Fishes

Fifteen non-native fish species are currently found in Grand Canyon (Table 2, GCMRC unpublished data; Valdez and Carothers 1998). The majority are warm-water species; only two are true cold-water species—rainbow trout and brown trout. The fish population in Glen Canyon (Lees Ferry) is dominated by rainbow trout, with small numbers of brown trout and local abundances of common carp (Ackerman 2008). The fish population in Marble Canyon is dominated by rainbow trout and carp with small numbers of seven other species. In Grand Canyon, dominant warm-water species are channel catfish and carp with local abundances of small minnows and sunfishes.

Recently, a few smallmouth bass (*Micropterus dolomieu*) and striped bass (*Morone saxatilis*) were collected in the vicinity of the LCR (GCMRC unpublished data), but no population-level establishment has been documented to date. There are also recent records of green sunfish, black bullhead, yellow bullhead (*Ameiurus natalis*), red shiner (*Cyprinella lutrensis*), plains killifish (*Fundulus zebrinus*) and largemouth bass (*Micropterus salmoides*) downstream from the LCR, usually associated with warm springs, tributaries, and backwaters (Johnstone and Lauretta 2007; GCMRC unpublished data). Striped bass are found in relatively low numbers below Lava Falls (Valdez and Leibfried 1999; Ackerman 2008). Common carp are relatively common downstream from Bright Angel Creek, although numbers declined from 2000 through 2006 (Makinster et al. 2010).

Non-native fish collected below Diamond Creek in 2005 (Ackerman et al. 2006) were comprised primarily of red shiner (28 percent), channel catfish (18 percent), common carp (12 percent), and striped bass (9 percent); smallmouth bass, mosquitofish (*Gambusia affinis*), and fathead minnow (*Pimephales promelas*) were also present in low numbers. Bridge Canyon Rapid (RM 235) impedes upstream movement of most fish species, except for the striped bass, walleye, and channel catfish (Valdez 1994; Valdez et al. 1995; Valdez and Leibfried 1999). Above Bridge Canyon Rapid, the red shiner was absent, but below the rapid it comprised 50 percent and 72 percent of all fish captured in tributaries and the mainstream, respectively (Valdez 1994; Valdez et al. 1995). Other common fish species found below Bridge Canyon Rapid include the common carp, fathead minnow, and channel catfish; however, very little fish habitat exists in this reach due to declining elevations of Lake Mead and subsequent downcutting of accumulated deltaic sediments in inflow areas.

3.2.1.6 Effects of High Flow Experiments on Fishes

Reclamation is developing an the HFE Protocol EA for the purpose of promoting more natural sediment dispersal throughout the Canyon and improving conditions for sediment-derived resources such as camping beaches. The HFE Protocol is being developed with the intention to allow for multiple high flow tests over a period of 10 years. The HFE Protocol would have effects to fishes under either no action or the proposed action if implemented. The SDM Project analysis results, along with other recent scientific findings, suggest that there is a close relationship between the decision to conduct high flow experiments and to implement non-native fish control because of the apparent effect that spring HFE flows have on trout recruitment in Lees Ferry. The coupled trout-chub models developed as part of the

SDM Project assessment provided some valuable predictions about the effects of HFEs on fishes (see Appendix A, Table 7). Wright and Kennedy (2011) also concluded available evidence indicates that HFEs may impact juvenile humpback chub due to the positive effect of HFEs on trout abundance and the negative effect of trout competition and predation on humpback chub and other native fishes. Wright and Kennedy (2011) reported that rainbow trout abundance in the LCR reach increased as a result of the 2008 HFE. They attribute this increase to downriver migration of the large 2008 rainbow trout cohort spawned in the Lees Ferry tailwater reach immediately after the 2008 HFE, together with local recruitment along downriver sections.

Results from the 1996 and 2008 spring HFEs indicate that high flow experiments have the potential to increase numbers of rainbow trout in Lees Ferry and likely influence the abundance of rainbow trout throughout Grand Canyon due to several factors. Korman et al. (2010; 2011) found multiple lines of evidence indicating that the March 2008 HFE resulted in large increases in abundance of rainbow trout in Lees Ferry due to improved habitat conditions for young-of-year rainbow trout. Numbers of young-of-year rainbow trout in July of 2008 were four-fold greater than would be expected based on numbers of eggs produced during the 2008 spawn based on stock-recruitment analysis. Survivorship was also greater for fish that hatched after the HFE based on hatch-date analysis, also indicating that habitat conditions were improved after the HFE. Growth rates of young-of-year rainbow trout were also as high as has been recorded in Lees Ferry, despite the fact that abundance was also much greater than previous years, suggesting a greater carrying capacity for young trout in Lees Ferry following the HFE (Korman et al. 2010; 2011). Korman et al. (2010; 2011) speculate that the 2008 HFE (41,500 cfs for 60 hours) resulted in these effects because the high flow increased interstitial spaces in the gravel bed substrate and food availability or quality, resulting in higher early survival of young-of-year rainbow trout, as well as improved growth of young trout. This improved habitat effect of the 2008 HFE also apparently carried over into 2009; trout abundance in 2009 was more than two fold higher than expected from egg counts (Korman et al. 2010; 2011).

Although there is less data from the 1996 and 2004 HFEs, those events appeared to have effects to rainbow trout as well. Trout abundance in Lees Ferry appeared to increase following the 1996 event which was conducted in April (Makinster et al. 2009b). During a three-week period that spanned the November 2004 HFE, abundance of age-0 trout, estimated to be approximately 7 months old at that time, underwent a three-fold decline; a two-fold decline was also observed in November-December 2008 (Korman et al. 2010). The decline observed during the 2004 HFE may have been due to either increased mortality or displacement/disbursal as a result of the higher flow (Korman et al. 2010). However, long-term trout monitoring data indicated that trout started to decline system-wide in 2001-2002 and declined through the period of the 2004 HFE and only began to recover in about 2007 (Makinster 2009b). Also, key monitoring programs to detect ecosystem pathways that affect rainbow trout in Lees Ferry were not in place at the time of the 2004 HFE (Wright and Kennedy 2011). Higher water temperatures and lower dissolved oxygen in fall 2005 also may have increased mortality and reduced 2006 spawning activity (Korman et al. 2010). Thus the overall effect of fall HFEs on rainbow trout abundance is unclear.

The HFE Protocol currently under development by Reclamation would provide for the opportunity to conduct multiple high flows over a 10-year period of from 31,500 cfs to 45,000 cfs for 1-96 hours. Proposed time frames are March/April and October/November, periods following the primary sediment-input season are of late summer/early fall and winter. A more detailed description of the proposed action can be found in the HFE Protocol EA (Bureau of Reclamation 2011). High flows conducted in the March/April period likely would result in improved conditions for rainbow trout based upon observations from the 1996 and 2008 HFEs. Given the increase in rainbow trout that apparently resulted from the 2008 spring HFE (Korman et al. 2010, Wright and Kennedy 2011), multiple HFEs over a 10-year period would reasonably be predicted to increase rainbow trout abundance system-wide including in the LCR Reach.

3.2.2 *Fish and Fish Habitat under No Action*

Under the no action alternative, no actions to control non-native fish would be taken for the 10-year period. The No Action alternative would implement MLFF for the 10-year period with steady flows in September and October 2011 and 2012. These dam operations have been previously evaluated through prior NEPA compliance, the 1995 EIS and 1996 ROD and the 2008 EA for Glen Canyon Dam operations (Bureau of Reclamation 1996, 1996, 2008). HFEs could also be conducted as an additional dam operation as described in HFE Protocol EA if the protocol is implemented (Bureau of Reclamation 2011). In general, the no action alternative is predicted to result in a potential deterioration of native fish species, including the humpback chub, and habitat for these species, including humpback chub and razorback sucker critical habitat, because non-native fish would be more likely to proliferate and predation losses of young native fish increase, reducing recruitment of these species.

Non-native fish predation has long been identified as a key threat to humpback chub in Grand Canyon (Minckley 1990, Valdez and Ryel 1995, Marsh and Douglas 1996). Wright and Kennedy (2011) found that rainbow trout appear to have a causal link to adult humpback chub population abundance, which is seen in population abundance trends for both species (Figure 3). When rainbow trout populations are large, humpback chub populations generally decline. Wright and Kennedy (2011) ascribe this relationship to a probable combination of increased competition and predation (citing Coggins, 2008; 160 Coggins and Walters, 2009; Coggins and Yard, 2010; Coggins et al. 2011; Yard et al. 2011). Currently both rainbow trout numbers and humpback chub numbers are high. This suggests that either the adult humpback chub population has not yet been affected by predation from the trout because it takes four years for juveniles to mature and recruit into the adult population, trout predation ultimately has no effect on the adult humpback chub population, or other factors, such as water temperature or flow volume are also effecting trout and humpback chub abundance.

Results from previous non-native fish removal efforts (Yard et al. 2011) of diet content analysis showed that although rainbow trout predation rate on humpback chub was relatively low, the overall loss of young humpback chub to predation by rainbow trout was substantial due to the high density of rainbow trout in the reach. Yard et al. (2011) found that during the 12 removal trips conducted from 2003-2004, 9,326 juvenile humpback chub were eaten by trout. Therefore reducing numbers of rainbow trout in the LCR reach (19,020 rainbow trout

were removed) effectively reduced predation losses of young humpback chub, a clear beneficial effect to the species, although other factors, such as warmer mainstem water temperatures in Grand Canyon during this period, confounded the overall effect of removal on humpback chub recruitment in the system (Andersen 2009; Coggins et al. 2011; Yard et al. 2011). Also during this period, rainbow trout declined system-wide, indicated both by abundance estimates from the control reach of the non-native control project and from monitoring throughout the system (Coggins et al. 2011; Makinster 2007). No action would not implement any removal efforts, and because numbers of rainbow trout are similar to abundances seen at the begging of the previous removal efforts (i.e. Yard et al. 2011 in 2003), losses of humpback chub due to predation would be similar.

An interesting early finding of the nearshore ecology study is that juvenile chub that occupy eddy complexes and talus slopes of the mainstem approximately 1.5 miles downstream from the LCR mouth have survivorship rates of 50-60 percent across 3 years of sampling (2008-2010; S. Vanderkoi, USGS, pers. comm. 2011). This suggests that high numbers of trout in this reach have apparently had little effect on juvenile survivorship, at least in the small percentage of habitats examined in the nearshore ecology study. Yard et al (2011) illustrates that clearly if non-native fish are not removed and controlled, then young humpback chub would continue to be consumed by non-native fish, predominantly trout, and trout would continue to compete with humpback chub for food and space. However, there is also evidence that there may be more factors at work which ultimately determine juvenile survival, recruitment, and adult humpback chub abundance. Juvenile humpback chub that survive (are not lost to predation or other causes) may have better survival because there are few humpback chub to compete against (known as compensatory survival). This survival may offset losses of young humpback chub to predation. This is an important aspect of non-native fish control to understand, because if predation on young humpback chub is high, but it ultimately has little effect on recruitment, removal of trout would have no effect on humpback chub recovery, and at great expense. One way to test this hypothesis would be to postpone removal long enough to detect an effect on adult humpback chub abundance, approximately four years, the length of time for humpback chub to mature into adults. The no action would provide for this experiment, because no removal would be implemented. However, if humpback chub adult abundance does decline over time due to trout predation, this alternative would provide no means to counteract this effect.

Thus the loss of young humpback chub to predation could have an effect on the population of humpback chub in Grand Canyon by reducing recruitment (Coggins and Yard 2009; Yard et al. 2011). The effect on the humpback chub population cannot be fully analyzed due to incomplete knowledge of the complexity of survival rates associated with a large number of variables that would translate to adult recruitment, including the uncertainty of numbers and sizes of chub eaten by trout, affects of cold mainstem water temperatures on young humpback chub, various annual densities of juvenile chub depending on year class strength, relationship of predator and prey densities, the causes and levels of other sources of mainstem chub mortality, and the contribution of young humpback chub reared in the mainstem to the adult population.

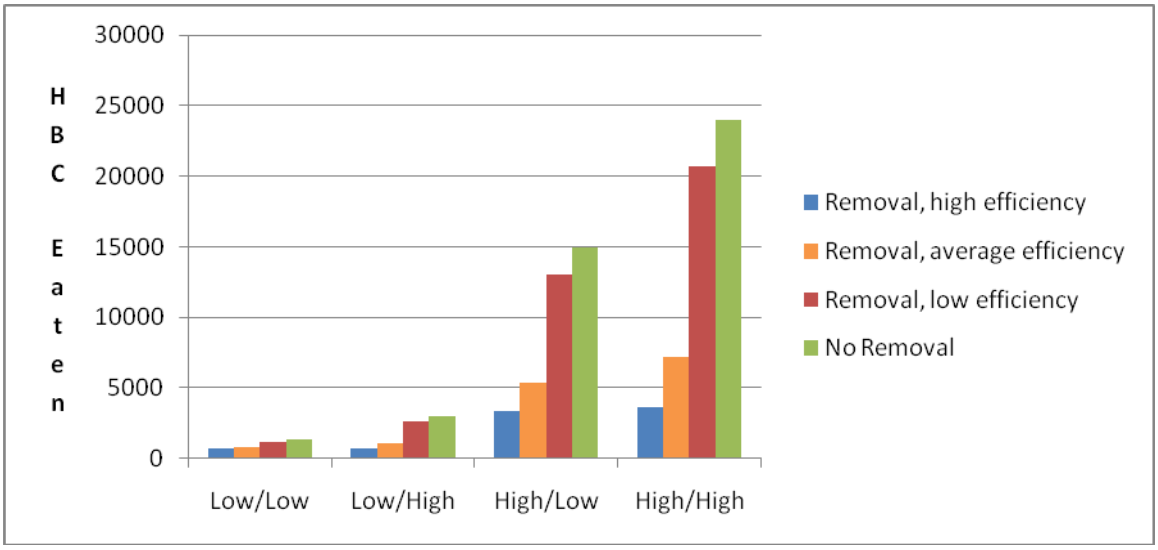

Figure 6. Expected predation of age-0 and subadult humpback chub by trout in the absence of non-native fish removal (green bars) and over a range of removal efficiencies (blue, orange and red bars). X-axis labels refer to assumptions on predator density and piscivory rates. For example, "Low/Low" refers to low levels of predatory density (as a function of trout immigration rates) and low piscivory rates (Yard et al. 2008). The amount of humpback chub that would theoretically be saved through removal efforts is represented by the difference between the green vertical bars and bars of other colors representing the various assumptions on immigration and predation rates (Bureau of Reclamation 2010).

Nevertheless, taking no action would result in losses of young humpback chub due to predation by rainbow trout and other non-native fishes that would not be removed which in turn could result in reductions in humpback chub recruitment and declines in the adult population. Using data from prior removal efforts, we can estimate what effect the no action may have humpback chub recruitment. An analysis of the effects of conducting two removal trips in the LCR reach is provided in Appendix C. Evaluation of population level effects was conducted by converting losses of age-1 humpback chub to losses of adult humpback chub, which is the metric identified in the Recovery Goals (U.S. Fish and Wildlife 2002) and the incidental take statement from the 2009 Supplemental and the 2010 ITS (U.S. Fish and Wildlife Service 2009, 2010). We applied published survival rates for humpback chub (Valdez and Ryel 1995; Coggins et al. 2006) to estimate numbers of preyed-upon humpback chub as described above. We then compared these losses to the minimum population size contained in the incidental take statement (6,000 adult humpback chub; U.S. Fish and Wildlife Service 2010b).

Depending on electrofishing efficiency, estimates of not conducting two non-native fish removal electrofishing trips in the LCR reach could increase predation pressure by rainbow trout substantially (Figure 6). An estimated 129-3,292 young humpback chub (age-0 and age-1) would be theoretically lost to predation under the low efficiency scenario, 532-16,851 humpback chub in the average efficiency scenario and 637 to 20,384 humpback chub in the high efficiency scenario. Losses of age-0 and age-1 humpback chub due to predation from not conducting two electrofishing trips would theoretically translate into losses of adult fish (Figure 7). Four to 96 fish would be lost as a result of predation in the low efficiency scenario, 15 to 491 fish in the average efficiency scenario and 19 to 594 humpback chub in

the high efficiency scenario. The grand mean of estimated fish lost from predation across all variables (predation and immigration rates as well as electrofishing efficiency) is 169 fish. Note that this estimate is for two LCR reach removal trips. The cost of not conducting additional trips would result in additional losses of young humpback chub, which would translate into fewer adult humpback chub in the adult population.

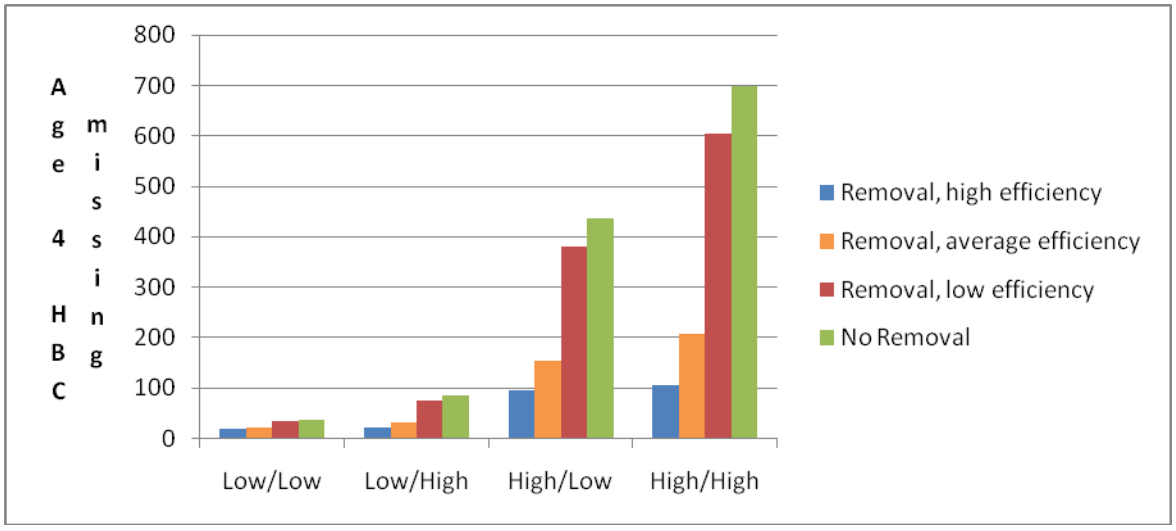

Figure 7. Expected losses of adult humpback chub (age 4+) due to predation by trout in the absence of non-native fish removal (green bars) and over a range of removal efficiencies (blue, orange and red bars, Bureau of Reclamation 2010).

Coggins and Walters (2009) estimated adult (age-4+) humpback chub population size in 2008 to be 7,650 fish. Based on annual mortality rates for humpback chub developed by Coggins et al. (2006) and Valdez and Ryel (1995), and the adult population estimate provided by Coggins and Walters (2009), to arrive at the 2008 population estimate, about 4,511 age-3 humpback chub would have had to be alive in 2007 to produce 2,346 age-4 fish in 2008, because mortality rates would result in a total loss of 2,165 fish (annual mortality of about 48%) between age 3 to 4. Assuming the population size is constant and rates of change remain the same for the next few years, the percentage of total annual mortality due to predation would be average adult fish lost to predation (315) divided by total fish lost to all mortality sources (2,165), or about 15% (a range of 2 – 32%). Thus if recruitment remains sufficient to keep total adult numbers stable or increasing over the next few years, effects of not conducting removal would likely not lead to a large decline in population size. Given the wide range of potential decline due to predation (2 - 32%) there is also some question as to whether a reduction in age-4 humpback chub in the main channel would be detectable under current protocols in the short term. However, over the 10 years of analysis for this EA, losses of humpback chub adults due to not conducting removal could be substantial and exceed incidental take as described in the 2010 revised Incidental Take Statement[7].

[7] On June 29, 2010, the U.S. District Court for the District of Arizona remanded the incidental take statement contained within the 2009 Opinion on Glen Canyon Dam operations back to the USFWS. USFWS reissued the incidental take statement as ordered on September 1, 2010, which essentially stated that take would be exceeded if the estimate of the adult humpback chub population dropped below 6,000 fish, using the Age-Structured

Losses of humpback chub due to brown trout could be large if their abundance would be comparable to those observed during 2003 and 2004 as described by Yard et al. (2011). Recent electrofishing data through 2009 shows that catch of brown trout in the LCR reach has increased little since a system-wide decline and catch per unit effort is lower than levels observed during 2003-2004 removal efforts (see Makinster et al. 2010, figure 4-C). Recolonization rates of brown trout into the LCR reach are also presumably low, partly because the nearest source population is about 25 miles downstream.

The NPS Bright Angel Creek removal project is ongoing and would continue under the no action alternative. 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). The Bright Angel Creek removal would be 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. 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. Both of these actions have been previously addressed through other compliance processes and are incorporated by reference herein. 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 electrofisihing; NPS also removed 1,220 rainbow trout and one brown trout from Shinumo Creek in 2009, and 929 rainbow trout in 2010. The cumulative effects of these actions are analyzed here, along with related effects of humpback chub translocations.

Other actions that could have a cumulative effect on fishes include translocations of humpback chub above Chute Falls in the Little Colorado River, to Shinumo and Havasu Creeks, and establishment of humpback chub refuge, all Reclamation conservations measures in ongoing section 7 biological opinions (U.S. Fish and Wildlife Service 2008, 2009). Translocation of humpback chub within the LCR has been occurring since 2003 and translocations from the LCR to Shinumo Creek has been occurred in 2009 and 2010. These actions appear to have benefited the species, as survivorship and growth of fish translocated above Chute Falls have been high (Stone 2009), and fish translocated into Shinumo Creek have exhibited rapid growth, have overwintered in Shinumo Creek, and have been detected moving into the mainstem Shinumo inflow aggregation (B. Healy, NPS, pers. comm. 2010). Additional translocations are planned for these creeks and for Havasu Creek. These projects are expected to continue to benefit the species by improving survivorship and expanding the range of the humpback chub. Reclamation has also assisted USFWS in creating a refuge population at Dexter National Fish Hatchery and Technology Center. This refuge serves as potential brood stock in the event a catastrophic loss of humpback chub in the Grand Canyon population should occur. Also worth considering are various planning documents of the NPS. The CRMP identified the potential of river running activities to adversely affect fishes, primarily from disturbance by recreational boat use, and the fish management plan that NPS is developing could also have direct effects to fishes.

Mark Recapture Model (Coggins and Walters 2009, U.S. Fish and Wildlife Service 2010). This revised ITS was subsequently upheld as in compliance with the ESA by the U.S. District Court.

Another potential effect of no action is increased competition between adult humpback chub and non-native fishes that would have been removed by the trips, in particular adult rainbow, and brown trout. Valdez and Ryel (1995) found that simulids, chironomids, and *Gammarus* were the three most prevalent diet items in 158 adult humpback chub stomachs sampled by gastric lavage in the mainstem Colorado River in Grand Canyon. Yard et al. (2011) also found that these same three types of aquatic invertebrates were important components of both rainbow and brown trout diets, often accounting for 40 to 90 percent of the diet by weight over a 1.75 year study from 2003-2004. Thus it appears that there is competition for food resources between trout and humpback chub, although the extent of this not fully understood in relation to overall food availability (i.e., if food resources are unlimited, then there would be no effect from competition). Ongoing food base research should provide insight into the effect of competition with trout in light of food availability.

As discussed above, conducting future HFEs under the proposed HFE Protocol could have adverse effects to humpback chub due to increased numbers of rainbow trout (Korman et al. 2010, Wright and Kennedy 2011). Under the no action alternative, there would be no means of controlling these increasing numbers of rainbow trout. This could further increase losses of young humpback chub to predation by rainbow trout. Although about 20,000 rainbow trout were removed from LCR reach from 2003-2006 (Coggins, 2008a; Coggins and Yard 2010), the large 2008 rainbow trout cohort that resulted from the March 2008 HFE , perhaps combined with local recruitment along downriver sections, contributed to an increase in rainbow trout densities in the vicinity of the Little Colorado River since 2006 (figure 3; Makinster and others, 2010; Wright and Kennedy 2010). Under these densities, losses of humpback chub to rainbow trout predation are likely to be similar to those observed by Yard et al. (2011). Yard et al. (2011) found that predation rates by rainbow trout varied from 1.7 to 7.1 prey/rainbow trout/year, and 27.3 percent of fish consumed were humpback chub. Assuming a trout population of 7,000 adult rainbow trout in the LCR reach, annual losses of juvenile humpback chub would be within a range of 2,820-13,568. However, as described in the science plan (Appendix B), although these studies illustrate that losses of humpback chub to rainbow trout predation are occurring, the ultimate effect of rainbow trout predation on the adult humpback chub is not known. Although humpback chub status has continued to improve since the late 1990s, a period that includes mechanical removal of rainbow trout (2003-2006 and 2009), a number of other factors, including warmer mainstem water temperatures during this period, may have contributed to the improvement in the humpback chub's status (Andersen 2009).

Critical habitat for both humpback chub and razorback sucker would likely deteriorate under 10 years of the no action alternative. Critical habitat for these species includes a biological environment primary constituent element (PCE; U.S. Fish and Wildlife Service 1994). The biological environment includes food base, and predation and competition from non-native species. Because the no action alternative would only included limited removal of non-native fishes in Bright Angel Creek and Shinumo Creek, non-native fishes would likely proliferate in the mainstem and in the LCR reach. These increases in non-native fish would reduce the quality of the biological environment PCE of critical habitat due to increased predation and competition from non-native fish species, and potential reductions in food base due to competition with non-native fish species.

The no action alternative is expected to have adverse effects to humpback chub and to humpback chub and razorback sucker critical habitat. This is because no non-native fish control would be conducted, with the exception of small-scale removal projects ongoing by the NPS in Bright Angel and Shinumo Creeks. Because no mainstem Colorado River removal efforts would be conducted, non-native fish species, especially trout, could proliferate to high densities. This effect could potentially be magnified if the HFE Protocol is implemented (Korman et al. 2011). Increases in non-native fish species would lead to increased predation and competition on endangered humpback chub (Yard et al. 2011), resulting in increased losses of humpback chub and potentially reduced recruitment, and reductions in adult abundance. The value of critical habitat for humpback chub and razorback sucker would also be reduced.

3.2.3 *Fish and Fish Habitat under the Proposed Action*

Dam operations for the 10-year proposed action would be MLFF with steady flows in September/October 2011 and 2012, and would also continue in accordance with the 1996 and 2007 RODs and 2007 Colorado River Interim Guidelines. These operations were previously evaluated through prior NEPA compliance, the 1995 EIS and 1996 ROD and the 2008 EA of Glen Canyon Dam operations (Bureau of Reclamation 1996, 1996, 2008). HFEs may also be conducted as an additional dam operation as described under in HFE Protocol EA (Bureau of Reclamation 2011).

The Proposed Action utilizes boat-mounted electrofishing to remove all non-native fish species in the PBR and LCR reaches of the mainstem Colorado River in Marble and Grand Canyons. Up to 6 LCR reach removal trips and up to 10 PBR reach removal trips could be conducted in any one year. 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 research to improve understanding of several aspects of the fishery in the action area related to improve understanding the effects of non-native fish predation. Research efforts would be implemented to improve estimates of young humpback chub (juveniles less than 150 mm in total length) to potentially refine a trigger for non-native fish control based on abundance of these young fish. This research would also help determine the overall importance of mainstem habitats to humpback chub recruitment. To better determine the degree to which emigration of rainbow trout from Lees Ferry is the source of rainbow trout in the LCR reach, a marking study would be initiated in the fall in Lees Ferry. Also, three to four downstream monitoring trips in the summer would monitor trout occurrence in Marble Canyon to attempt to detect marked fish from Lees Ferry moving downstream. PBR reach removal would begin testing in the winter months with two removal trips in the first year. The marking and PBR removal trips would enable researchers to begin to answer science questions associated with the numbers of trout emigrating from Lees Ferry, and in evaluating the effectiveness of PBR removal at limiting trout emigration to downstream areas. LCR Removal would be reserved for implementation only if adverse effects are detected, 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). . Removal and research actions in out years would be implemented through adaptive management based on monitoring and research results.

Two electrofishing removal trips in the PBR reach would have unknown effects on trout predation and competition effects to humpback chub downstream in the LCR reach. This is because removal has never been attempted in this reach. This is why the proposed action also included LCR reach removal in the event the 2011 Opinion trigger is reached. In results of the SDM Project analysis, adding PBR reach removal to LCR reach removal improved performance of an alternative on maintaining the adult humpback chub population. The predictive population models used to evaluate the consequences of policy alternatives on humpback chub and rainbow trout objectives in the SDM Project analysis involved a set of 3 coupled models. The elements of this coupled model included: (1) Emigration from Lees Ferry into Marble Canyon, (2) dynamics of rainbow trout during movement from Lees Ferry to LCR, and (3) the interaction between rainbow trout and humpback chub in the LCR (Fig. 4). Rates of rainbow trout emigration from Lees Ferry into Marble Canyon were based on analysis of Lees Ferry recruitment in year t and monthly emigration in year t+1. The proposed action was the best performing alternative in the SDM Project analysis because these models indicated emigration from Lees Ferry can be at least partially controlled by removal in the PBR reach.

As with no action, we analyzed the effect of the proposed action by assessing the effect of doing two non-native fish removal trips in the LCR reach, should LCR removal be necessary because the humpback chub trigger in the LCR reach had been exceeded. Additional LCR reach trips would have a stronger effect, and the effect of PBR trips is unknown because removal there has not been attempted. Conducting even two LCR removal trips could reduce predation pressure by rainbow trout substantially. If the removal has low efficiency, total humpback chub predation would be reduced by 10-14% depending on immigration rates and individual trout predation rates. Assuming average electrofishing efficiency, total humpback chub predation would be reduced by 41-70%, and 49-85% under high efficiency conditions depending on immigration rates and individual trout predation rates. Similarly, 129-3,292 humpback chub would be theoretically saved from predation under the low efficiency scenario, 532-16,851 humpback chub in the average efficiency scenario and 637 to 20,384 humpback chub in the high efficiency scenario.

Two LCR reach removal trips have been estimated to prevent losses of age-0 and age-1 humpback chub due to reduced predation year classes, and would theoretically translate into more adult fish (Figure 7). Four to 96 fish would survive due to reduced predation in the low efficiency scenario, 15 to 491 fish in the average efficiency scenario, and 19 to 594 humpback chub in the high efficiency scenario. The grand mean of estimated fish saved from predation across all variables (predation and immigration rates as well as electrofishing efficiency) is 169 fish. Note that this estimate is for two LCR reach removal trips. Additional removal trips would likely not result in a linear increase in adult humpback chub saved, but would result in substantial additional increases in fish saved. However, as discussed in the no action section, questions remain concerning the degree of effect of predation on humpback chub. The proposed action would only implement removal in the

LCR reach 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). . By taking this approach, the proposed action would provide the opportunity to better understand the effects of predation on humpback chub, and would only implement removal in the culturally-sensitive LCR reach if necessary.

This alternative would not affect other aquatic resources other than the collateral effects of electrofishing on native fish species and macroinvertebrates. The effects of electrofishing on Colorado River endangered fishes including humpback chub were reviewed by Snyder et al. (2003). Electrofishing can result in harmful effects on fish. Spinal injuries and associated hemorrhages have been documented in fish examined internally. These injuries are thought to result from convulsions of the body musculature, likely caused by sudden changes in voltage. Fewer spinal injuries have been reported with the use of direct current and low-frequency pulsed direct current, as opposed to alternating current. However, Snyder et al. (2003) found that endangered cyprinids of the Colorado River Basin, including humpback chub, are generally much less susceptible to these effects than other fishes. Mortality, when it has been documented, is usually due to asphyxiation, a result of excessive exposure to electrodes or poor handling of captured specimens. Effects of electrofishing on reproduction are contradictory, but electrofishing over spawning grounds can harm embryos. Snyder et al. (2003) concluded from the review that:

> "The survival and physical condition of endangered and other native cypriniforms (including razorback sucker) that had been electrofished in recapture and radiotag investigations… suggest that electrofishing injuries or mortality are probably not a serious problem. Even so, the sensitivity of the matter warrants a heightened awareness of the potential for electrofishing injuries, a continuing effort to minimize any harmful impacts by every practical means, and a readiness to adjust, alter, or abandon electrofishing techniques if and when potentially serious problems are encountered… Electrofishing is a valuable tool for fishery management and research, but when resultant injuries to fish are a problem and cannot be adequately reduced, we must abandon or severely limit its use and seek less harmful alternatives. This is our ethical responsibility to the fish, the populace we serve, and ourselves."

For the proposed action, ESA section 10(a)(1)(A) recovery permits from the USFWS would be required to conduct removal activities. These recovery permits would address the take associated with collateral effects of electrofishing and handling to humpback chub from the proposed action.

The NPS ongoing actions of removal of non-native fish, predominantly trout, from Bright Angel and Shinumo creeks would be expected to continue under the proposed action. 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). 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 also committed to continuing to fund and to help expand this effort as a

conservation measure in the 2011 Opinion (U.S. Fish and Wildlife Service 2011)Removal of trout from Bright Angel Creek would augment removal actions of the proposed action and potentially reduce numbers of predators in the LCR reach to the benefit of humpback chub and other native fish. Bright Angel Creek also appears to be the primary spawning ground for brown trout in the system, so this project could substantially reduce predation by brown trout.

As described in our analysis of no action, other actions that could have a cumulative effect to fishes include translocations of humpback chub above Chute Falls in the Little Colorado River, to Shinumo and Havasu Creeks, and establishment of humpback chub refuge, all Reclamation conservations measures in ongoing section 7 biological opinions (U.S. Fish and Wildlife Service 2008, 2009, 2011), as well as NPS implementation of planning documents described in section 1.7.3. Translocation of humpback chub within the LCR has been occurring since 2003 and translocations from the LCR to Shinumo Creek has been occurred in 2009 and 2010. These actions appear to have benefited the species, as survivorship and growth of fish translocated above Chute Falls have been high (Stone 2009), and fish translocated into Shinumo Creek have exhibited rapid growth, have overwintered in Shinumo Creek, and have been detected moving into the mainstem Shinumo inflow aggregation (B. Healy, NPS, pers. comm. 2010). Additional translocations are planned for these creeks and for Havasu Creek. These projects are expected to continue to benefit the species by improving survivorship and expanding the range of the humpback chub. Reclamation has also assisted USFWS in creating a refuge population at Dexter National Fish Hatchery and Technology Center. This refuge serves as potential brood stock in the event a catastrophic loss of humpback chub in the Grand Canyon population should occur. Reclamation has committed to continue to support maintenance of this refuge as a conservation measure of the 2011 Opinion (U.S. Fish and Wildlife Service 2011).

Rainbow trout abundance in Lees Ferry could be affected by the proposed action. Although the trout in Lees Ferry would not be directly affected, there could still be effects to the population if fish removed in the PBR reach, and perhaps the LCR reach, reduce overall abundance in the system. Reducing the numbers of trout in the system could result in both positive and negative effects to the Lees Ferry sport fishery which are discussed in Section 3.4.2.1.

In addition to the actions described above, Reclamation would also continue to investigate other alternatives under the proposed action. As part of the adaptive management process, Reclamation plans to evaluate development of other non-native fish suppression options, with stakeholder involvement, that 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 to test their ability to reduce the recruitment of trout in Lees Ferry, and lower trout emigration from Lees Ferry. These actions could benefit humpback chub by reducing numbers of rainbow trout in the system, and could also improve conditions of the recreational trout fishery at Lees Ferry. Additional environmental compliance may be necessary for these experiments.

Critical habitat for both humpback chub and razorback sucker would likely improve under 10 years of the proposed action alternative. Critical habitat for these species includes a biological environment PCE (U.S. Fish and Wildlife Service 1994). The biological environment PCE includes food base, and predation and competition from non-native species. Because the proposed action alternative would implement potentially both PBR and LCR reach removal, and would include the NPS ongoing actions of removal of non-native fishes in Bright Angel Creek and Shinumo Creek, non-native fish abundance would likely decrease in the mainstem and in the LCR reach. These decreases in non-native fish would increase the quality of the biological environment PCE of critical habitat due to reduced predation and competition from non-native fish species, and potential increases in food base available to native fish.

The proposed action alternative is expected to have beneficial effects to humpback chub and to humpback chub and razorback sucker critical habitat. This is because non-native fish control would be conducted potentially in both the PBR and LCR reaches, augmenting ongoing removal projects by the NPS in Bright Angel and Shinumo Creeks which Reclamation will also continue to help fund and implement through the GCDAMP as conservations measures of the 2011 Opinion. Abundance of non-native fish species, especially trout, would be expected to decline. The potential adverse effect of HFEs resulting in increases in rainbow trout would potentially be mitigated by removal efforts. Decreases in non-native fish species would lead to decreased predation and competition on endangered humpback chub, resulting in increases in young humpback chub and potentially increased recruitment, and increases in adult abundance. The value of critical habitat for humpback chub and razorback sucker would also be improved. Reclamation has reviewed the best available science, and, using our technical expertise to interpret the science, our conclusion is that the proposed action represents the best option to implement the non-native fish control conservation measure in a way that satisfies our legal commitments and responsibilities under the ESA, is protective of the humpback chub, and is least damaging to cultural and other resources.

3.3 *Cultural Resources*

The Grand Canyon of the Colorado is significant for its human history and its ongoing role in the lives and traditions of American Indians of the Colorado Plateau. Cultural resources include historic properties which are defined as districts, sites, buildings, structures, and objects that are eligible for listing on the National Register of Historic Places. Cultural resources also include Indian sacred sites as defined by Executive Order 13007.

Cultural resources include historic properties which the National Historic Preservation Act (NHPA) defines (16 USC 1470w) as districts, sites, buildings, structures, and objects that are eligible for listing on the National Register of Historic Places.

Cultural resources also include Indian sacred sites as defined by Executive Order 13007. Under Executive Order 13007, an Indian sacred site is defined as a specific, discrete, narrowly delineated location on Federal land that is identified by an appropriately

authoritative representative of an Indian religion as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion.

3.3.1 *Sacred Sites under No Action*

The Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, and the Pueblo of Zuni are concerned with the taking of life in the Grand Canyon and particularly in the vicinity of the confluence of the Colorado and Little Colorado rivers.

Under no action, both Reclamation and the NPS, as the executive branch agencies with statutory or administrative responsibility for the management of the Indian sacred sites, have continuing obligations under EO 13007 to ensure that, where practicable and appropriate, reasonable notice is provided of any proposed actions that might restrict future access to the site or adversely affect its physical integrity. Under no action, no non-native fish would be removed or killed, thus there would be no effect to sacred sites.

3.3.2 *Sacred Sites under the Proposed Action*

The Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, and the Pueblo of Zuni consider the proposal an adverse effect on an Indian sacred sites due to the taking of life associated with the proposed action. These tribes are being consulted with on a government-to-government basis regarding how these adverse effects might be minimized or mitigated.

3.3.3 *Historic Properties under No Action*

Section 106 of the NHPA requires Federal agencies to consider the effects of their actions on historic properties and to seek comments from an independent reviewing agency, the Advisory Council on Historic Preservation (Council). Under section 106, review is also required by the Arizona State Historic Preservation Officer and the Hualapai and Navajo Nation Tribal Historic Preservation Officers (see 36 CFR 800).

With the 1992 amendments to the NHPA, Congress added section 101(d)(6)(A) specifying that properties of traditional religious and cultural importance to an Indian tribe may be determined to be eligible for inclusion on the National Register of Historic Places. These are termed Traditional Cultural Properties (TCPs). Congress also added section 101(d)(6)(B), directing Federal agencies, in carrying out their responsibilities under section 106 of the NHPA, to consult with any Indian tribe that attaches religious and cultural importance to historic properties.

Under no action, no effects are anticipated to occur to historic properties. The Navajo Nation has indicated that they believe conservation of the humpback chub, including non-native fish control, is essential.

3.3.4 *Historic Properties under the Proposed Action*

The area of potential effect of the proposed action is the Colorado River, and that portion of the adjacent shoreline that might be affected by related research and monitoring. Reclamation and the NPS agree with the tribes that the Colorado River and floodplain are considered eligible historic properties (TCPs) under the NHPA and the eligibility determinations have been submitted to the Arizona State Historic Preservation Officer (SHPO).

The APE includes two historic districts, one a National Register listed district at Lees Ferry in GCNRA; the other an historic district in GCNP that has been determined eligible to the Register through consensus. Appendix F is the consultation letter with the Arizona State Historic Preservation Officer. Identical letters were sent to other consulting parties.

Application of the criteria of effect and the NPS's policies in National Register Bulletin 15 resulted in a finding of adverse effect for the proposal, given the concerns of the tribes. The Governor of the Pueblo of Zuni sent Reclamation a Zuni Tribal Council Resolution, No. M70-2010-C086, that states that the Zuni Tribe's position is that the Grand Canyon and Colorado River are Zuni traditional cultural properties eligible to the National Register of Historic Places. The Hopi tribe has also submitted documentation to the Bureau of Reclamation identifying the Grand Canyon, including the project area, as a Traditional Cultural Property. The Arizona State Historic Preservation Office concurred with Reclamation's determination of eligibility and effect on July 28, 2011.

Consultation to complete a Memorandum of Agreement to resolve adverse effects is underway in accordance with 36 CFR 800.6. Reclamation is committed to completing the process of resolving adverse effects with the tribes and other interested parties prior to implementation of the proposed action.

3.4 *Socioeconomic Resources*

Social and economic conditions were examined to determine whether the proposed action would affect them. The indicators reviewed include Indian trust assets, recreation, and environmental justice (E.O. 13175).

3.4.1 *Recreation under No Action*

Recreational resources of concern include trout fishing and recreational boating from Glen Canyon Dam to Lees Ferry, whitewater boating through Grand Canyon, and the Hualapai Tribe's boating enterprise at the western end of Grand Canyon and into Lake Mead.

3.4.1.1 Fishing under No Action

The approximately 15-mile reach between Glen Canyon Dam and Lees Ferry is heavily used by visitors.[8] Most of the whitewater boating trips through the Grand Canyon launch from

[8] This reach of the Colorado River is known as the Lees Ferry reach and is also known as the Glen Canyon reach.

Lees Ferry. Many hiking, fishing, day-use boating, and some camping trips also take place in this reach of the Colorado River.

The AGFD and NPS manage the tailwater (the Colorado River from below the Glen Canyon Dam to Lees Ferry) for sport fishing. There is a popular non-native rainbow trout fishery in the Lees Ferry reach and for some distance downstream. Most fishing occurs from boats or is facilitated by boat access, including guide services, but some anglers wade in the area around Lees Ferry and fish downstream into the PBR reach. As described in Loomis et al. (2005), the quality of the fishery had fallen and angler use had declined dramatically in recent years, from more than 20,000 anglers in 2000 to less than 6,000 in 2003. Fishing use increased to approximately 13,000 user days in 2006 (Henson 2007) and fell to approximately 9,800 user days in 2009 (G. Anderson, NPS, pers. comm. 2010). Heaviest fishing use occurs in April and May (Figure 8).

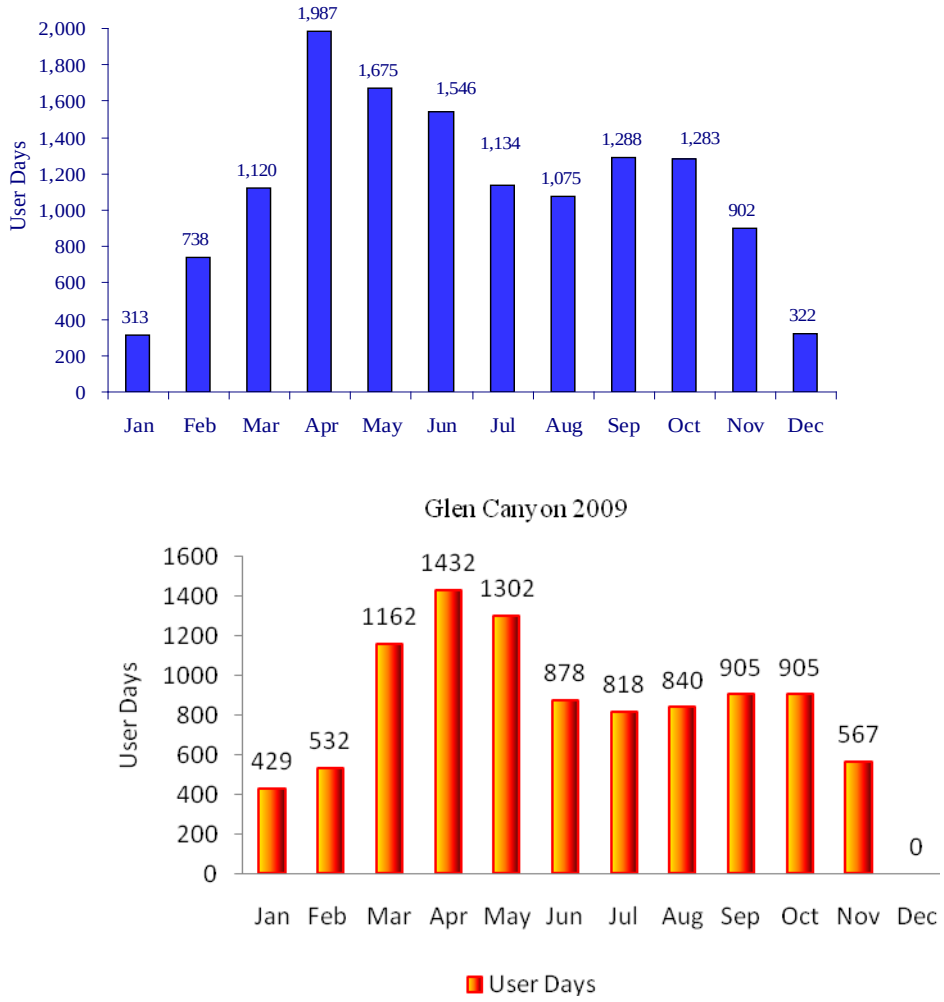

Figure 8. Fishing user days by month in the Lees Ferry reach for 2006 (top) and 2009 (bottom).

Under the no action alternative, there would be no effect on the fishery. No control actions would be implemented.

3.4.1.2 Recreational Boating under No Action

For river management purposes, the Colorado River is divided into two reaches. The upper reach runs from Lees Ferry (river mile (RM) 0) to Diamond Creek (RM 226) and is known as the Marble/Grand Canyon reach or upper river. The lower reach or lower river, starts at Diamond Creek (RM 226) on the Hualapai Reservation and goes to Lake Mead (RM 277).

The 15-mile reach between Glen Canyon Dam and Lees Ferry is heavily used by day-use boaters who take one-half day scenic boat trips offered by a NPS concessionaire. Day-use boating in Glen Canyon is a trip in a motorized or oar powered boat in a reach of the Colorado River that is without any noticeable rapids or rough water. The trip leaves from the town of Page, AZ and begins with a ride down the two-mile long Glen Canyon access tunnel. These scenic trips are on calm water without rapids and launch at the base of Glen Canyon Dam and are a motorized float through the 15-mile reach to Lees Ferry.

There were about 50,411 user days of day-use boating during 2009 and 53,340 user days of day-use boating in 2010 (J. Balsom, NPS, pers. comm. 2011). The majority of the day-use boating visitation takes place during the summer months and June is typically the peak use month. There is little or no day use boating in the winter months.

Under the no action alternative, there would be no effect on day-use rafting. No control actions would be implemented.

Boating (kayaking, boating, canoeing, etc.) in the upper reach below Lees Ferry is internationally renowned. In 2006, the NPS completed a new *Colorado River Management Plan* (CRMP) for whitewater boating through Grand Canyon National Park (National Park Service 2006c). This management plan governs use in both the reach from Lees Ferry to Diamond Creek and the reach from Diamond Creek down to Lake Mead. Under this plan, total whitewater boating use was increased and the distribution of that use during the year was altered. Annual use in the Marble/Grand Canyon reach is expected to be no more than 115,500 commercial user-days and approximately 113,500 private user-days (National Park Service 2006c). Highest-use months for commercial operations extend from May through September, but are relatively consistent throughout the year for noncommercial boating (Figure 9). The CRMP allows up to 1,100 total yearly launches (598 commercial trips and 504 noncommercial trips). Up to 24,567 river runners could be accommodated annually if all trips were taken and all were filled to capacity.

Under the no action alternative, there would be no effect on the number of visitors participating in rafting. No control actions would be implemented.

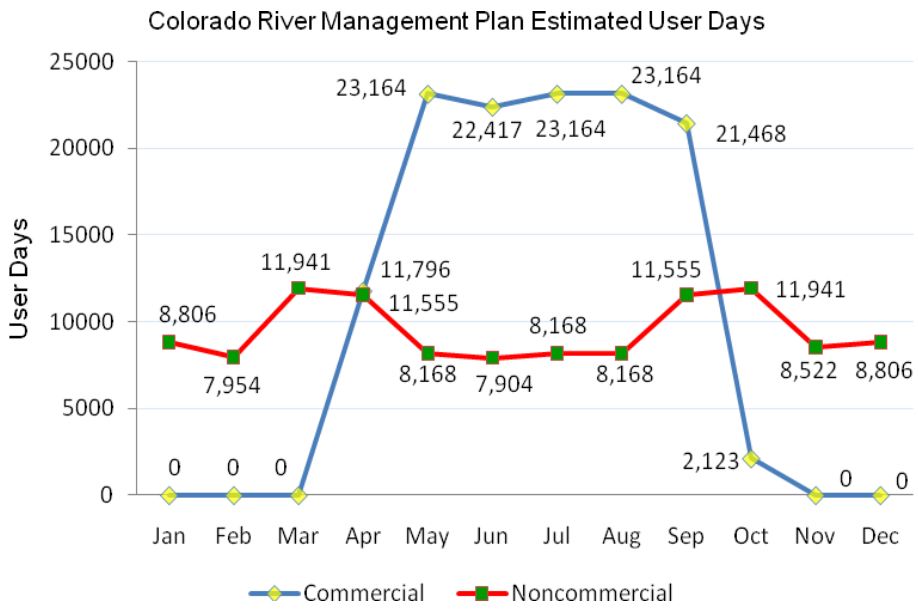

Figure 9. Recreational boating in the Grand Canyon, annual use by month (National Park Service 2006c).

3.4.1.3 Net Economic Use Value of Recreation under No Action

Recreation and the tourism industry are important economic sectors on the Hualapai Indian Reservation. Hualapai River Runners (HRR), the commercial rafting operation run by the Hualapai Tribe, provides guided day use and overnight use trips as well as the separate concession run day-use boat operation directly depend upon the Colorado River for their existence. Other recreation and hospitality operations (restaurant, hotel, skywalk, etc.) also have connections to the Grand Canyon if not the river itself. The various recreational-related enterprises generate a large proportion of the total revenue earned by the Hualapai Tribe. This revenue supports the tribal economy and creates jobs for its members. Much investment in infrastructure has been made to induce increased tourism on the reservation, e.g. the skywalk.

Visitors to Lees Ferry and the Grand Canyon spend large sums of money in the region purchasing gas, food and drink, lodging, guide services, and outdoor equipment while visiting the region. These expenditures impact the regional economy through direct effects, indirect effects, and induced effects. Direct effects represent a change in final demand for the affected industries caused by the change in spending. Indirect effects are the changes in inter-industry purchases as industries respond to the new demands of the directly affected industries. Induced effects are the changes in spending from households as their income increases or decreases due to the changes in production.

The regional economic activity that results from nonresident anglers, recreational boaters, and day boaters who visit Glen and Grand Canyons was estimated in a previous study at approximately $25.7 million in 1995 dollars (Bureau of Reclamation 1995). Douglas and Harpman (1995) estimated that Glen Canyon and Grand Canyon recreational use in the region comprised of Coconino and Mojave Counties supports approximately 585 jobs. A

more recent study by Hjerpe and Kim (2003) estimated that recreational use in Coconino County (alone) supports approximately 394 jobs.

The region as defined in this analysis is Mohave and Coconino Counties in Arizona which corresponds with past economic studies of the impacts of changes in Glen Canyon Dam operations. Flagstaff, in southeast Coconino County, is the largest city in this nearly 32,000 square mile mostly rural region. In 2007 the area supported over 138,000 jobs and produced more than $15 billion worth of goods and services (Table 3). Labor earned more than $4.8 billion in total compensation.

Table 3. Mohave and Coconino Counties, Arizona – Baseline Socioeconomic Data (in 1,000's; Minnesota IMPLAN Group, Inc. 2008).

Industry Category	Employment	Output	Employee Compensation	Proprietor Income	Other Property Type Income	Indirect Business Taxes
Agriculture	753	$90,035	$12,054	$3,149	$9,072	$2,684
Mining	257	$67,968	$11,338	$3,173	$23,070	$3,811
Construction	11,621	$1,541,069	$376,239	$126,497	$91,944	$9,856
Manufacturing	7,695	$2,491,463	$435,518	$13,374	$261,766	$12,462
TIPU	4,321	$684,106	$177,976	$32,383	$108,207	$27,217
Trade	22,485	$1,670,373	$604,674	$106,965	$175,621	$250,340
Service	65,943	$6,714,451	$1,838,582	$369,220	$1,326,742	$318,646
Government	25,193	$1,777,551	$1,346,715	$0	$200,779	$0
Total	138,268	$15,037,014	$4,803,097	$654,761	$2,197,201	$625,018

Economic impacts on the Navajo were not estimated in previous evaluations of changes of operations at Glen Canyon Dam on recreation and recreation economics because it was thought that there was no connection between the river flows and recreation and the Navajo Nation and fiscal or economic benefits. However, representatives of the Navajo indicated they believe there is a connection.

Navajo tradespeople who make their living selling jewelry and souvenirs to the traveling public along routes 89 and 89A have seen their business decline in recent years. The relatively high income clientele of the fishing guides were especially important (R. Lovett 2010, Marble Canyon Outfitters, pers. comm. 2010; W. Gunn, Lees Ferry Anglers Guides and Fly Shop, pers. comm. 2010). The reduction in the fishing guide business has been felt by the Navajo tradespeople and crafts workers. The Navajo vendors selling jewelry and souvenirs along highways 89 and 89A have had their sales and income greatly reduced in recent years. The recent recession added to the decline in visitation to Lees Ferry to further reduce the traffic along routes 89A and 89 reducing the potential customer base for Navajo made products sold by Navajo vendors at the roadside stands resulting in increased economic hardship. Any loss of income or jobs affects not only the individual but usually other workers (the makers of the products sold) and the worker's extended family.

In the last ten years there have been as many as 99 individual vending stands where handmade Navajo jewelry and souvenirs were sold at the 33 pullouts along highways 89 and 89A (M. Christie, Antelope Valley Trade Association, pers. comm. 2010). Now this number

has been reduced to 80 stands. Four of these stands are affiliated with the Antelope Trails Vending Organization (ATVO).[9] The other stands are individually owned. Each pullout may have from one to 10 selling stands with one to two people or perhaps a whole family participating in the business. Jewelry vending and production is a primary employment sector of the economy in this part of the Nation for the Navajo people providing 400 to 700 jobs (Table 4). Jobs held by the Navajo people are especially important due to the long-term high rate of unemployment on the Nation and due to the fact that wage earners usually are supporting extended families.[10]

Table 4. Navajo Roadside Vending and Employment (Employment numbers are estimates, M. Christie, Antelope Valley Trade Association, pers. comm. 2010).

Highway	Location	# of Pullouts with Vending Businesses	# of Employed People Vending**	# of Employed People Producing Products
Route 89	Page to Bitter Springs	3	4 + family members helping	–
Route 89A	Marble Canyon to Bitter Springs	6	12	12 to 20
Route 89A	Marble Canyon to Jacob Lake	3	12 to 20	200 + family members
Route 89	Bitter Springs to Gray Mountain	21	65 to 140	130 to 280
		33	93 to 176	342 to 500

Members of the Bodaway/Gap Chapter of the Dine′ Nation have indicated that non-native fish control may affect their way of life (the Navajo use the beaches for sacred ceremonies and they fish for recreation and for food) and adversely affect their sales of items to the visiting tourists.

There are many other factors affecting the amount of traffic and numbers of potential souvenir buyers on the roads. Right now unemployment and economic uncertainty are huge factors in people's decisions to travel or vacation in northern Arizona and whether or not to purchase items from Navajo roadside stands. However, even though non-native fish control may or may not negatively affect the rainbow trout fishery at Lees Ferry the perception by the Navajo is that many actions taken at Glen Canyon Dam in Lees Ferry and Grand Canyon can negatively impact their souvenir sales.

Under the no action alternative, there would be no effect on the net economic value of recreational use. No control actions would be implemented.

[9] ATVO has 170 individual members. The members rotate among the four sites so each has a chance to sell their merchandise. Each business may sell at a different site on different days of the month. Not all members sell every day.

[10] The Nation is an area that has chronic high unemployment and high poverty rates. In 1999 per capita income was $7,578, only 35 percent of the national average of $21,587. While the national poverty rate for individuals in 1999 was 12.4 percent; the Nation's poverty rate was 41.9 percent.

3.4.1.4 Nonuse Economic Value under No Action

Social scientists have long acknowledged the possibility that humans could be affected by changes in the status of the natural environment even if they never visit or otherwise use these resources. These individuals may be classified as non-users, and economic expressions of their preferences regarding the status of the natural environment are termed "nonuse" or "passive use" value. A straightforward and readily available overview of this topic is provided by King and Mazzotta (2007).

Aquatic and riparian resources along the Colorado River are directly affected by the operations of Glen Canyon Dam. Although visitation to Glen Canyon National Recreation Area and the Grand Canyon National Park is quite extensive, only a very small proportion of these visitors physically use these riverine resources. Nonetheless, visitors to the Grand Canyon and members of the general public hold strong preferences about the status of these resources.

In the late 1980's, the National Academy of Science Committee to Review the Glen Canyon Environmental Studies recommended that a study be commissioned to estimate nonuse value for Grand Canyon resources (National Academy of Sciences 1987). As related in Harpman et al. (1995), the Bureau of Reclamation retained an independent consulting company to complete an analysis of total economic value for the Glen Canyon EIS. Welsh et al (1995) undertook a comprehensive study of nonuse value for Glen and Grand Canyon resources. Their research encompassed both individuals residing within the area where electricity from the dam is sold and all citizens of the United States. The survey instrument was painstakingly designed following a series of focus groups, a peer review, and an extensive pilot-test. Survey response rates were exceptional; 83% and 74% for the power marketing area and national samples respectively. In many respects, these response rates demonstrated the saliency of these resources to stakeholders and members of the public.

As shown in Table 5, Welsh et al, (1995) estimated the average nonuse value (that is, when asked what they were willing to pay to implement certain actions, the response, for three flow regimes) for U.S. households was $18.74 (indexed to 2008 dollars) for the moderately low fluctuating flow alternative. When expanded by the pertinent population, this yields an aggregate estimate of $3,159.21 million per year (in 2008 dollars) for the national sample.

Table 5. Estimates of Nonuse Value for Three Flow Scenarios Relative to Historical Operations (Welsh et al. 1995).

Flow Scenario	National Sample Value Per Household (2008 $)	National Sample Aggregate Value (millions of 2008 $)
Moderate fluctuating flow	$18.74	$3,159.21
Low fluctuating flow	27.84	4,660.88
Seasonally Adjusted Steady flow	$28.39	$4,756.22

The findings of this study clearly illustrate the significance of Grand Canyon resources and the value placed upon them by members of the public. Although the results of the nonuse value study were unavailable for inclusion in the *Operation of Glen Canyon Dam EIS*, they were cited and summarized as Attachment 3 in the Record of Decision (U.S. Department of

the Interior 1996). Although the NPS is currently in the process of a new study of nonuse values for the park units along the Colorado River, which will likely update some of the findings of the 1995 study, this study was not completed for use at the time of this EA.

The Hopi Tribe believes that its cultural values for the Grand Canyon should be considered within the Western analysis framework as non-use values. Management actions that occur there can have effects at Hopi that do not depend on whether Hopi people enter (use) the Grand Canyon or not. The no action alternative would have no effect to Hopi non-use values.

The effect of no action may have an effect on nonuse values considering that the ecosystem would not benefit from the removal on non-native fish species and humpback chub adult abundance could decline. This could result in a decline in nonuse value.

3.4.2 *Recreation under Proposed Action*

3.4.2.1 Fishing under Proposed Action

The Colorado River from below the dam to Lees Ferry is an important recreational rainbow trout fishery, attracting anglers from the state and beyond. Most angling occurs from boats in the Lees Ferry reach, i.e., the 15 miles of river below the dam. Navajo Nation tribal members also periodically fish for trout in the Lees Ferry area. The NPS does not allow any commercialization of fishing below Lees Ferry. The Arizona Game and Fish Department sets bag limits for trout below Lees Ferry through Grand Canyon. Current fishing regulations allow for the harvest of six rainbow trout and unlimited harvest of all other sportfish from the Paria riffle to Navajo Bridge. Below Navajo Bridge (to Separation Canyon) there is no limit on angler harvest of sportfish species.

With regard to sport fishing in the Lees Ferry reach, the SDM Project analyzed the effect of this and the other alternatives on both catch rate and the percent of fish captured over 20 inches in total length. This alternative had no effect on either of these variables. Removal in the LCR reach is far enough away that it would have no effect on trout numbers or size classes in Lees Ferry. Although removal in the PBR reach is much closer, trout removed are predicted to be of young fish that are emigrating out of the Lees Ferry reach downstream. Removing these fish is not expected to have any effect on the adult population of trout in Lees Ferry. However, if this assumption is false, and PBR-reach removal does have an effect on the overall population of adult trout in Lees Ferry, the net result could conceivably be a reduction in catch rates and an increase in the size of adult fish caught. This effect was seen in the SDM Project analysis for alternatives that contain actions which more directly affected the overall Lees Ferry population (as opposed to fish that are emigrating) such as flow manipulations designed to strand young trout. Such a result could be beneficial to the Lees Ferry trout fishery because it could result in a healthier, more sustainable population with a balanced age-structure with larger trout of better condition.

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, only 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. 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.

Although the proposed action is not expected to result in any adverse or beneficial effect on the quality of sport fishing in Lees Ferry, because there may be up to 10 removal trips in the PBR reach each year, and these trips would operate out of Lees Ferry, there could be some effect in the form of disturbance to anglers and fishing guides in Lees Ferry. However, removal crews would be working the 7-mile PBR reach downstream from Lees Ferry. Lees Ferry anglers and fishing guides utilize the Glen Canyon section of Lees Ferry, that is the 15 miles of the river from Lees Ferry upstream to Glen Canyon Dam. Fisherman also utilize the section of the river downstream of Lees Ferry to about Jackass Canyon for shore fishing, as well as other hike in sites downstream, such as Soap Creek, Salt Creek, Houserock, and South Canyon. Removal in the PBR reach is likely to cause some level of disturbance to the angling community that shore fishes in this area, and a reduction in fish numbers may also affect catch rates for these anglers. The primary aspect of disturbance would be in the form noise and visual intrusion from boats launching from Lees Ferry either to perform short duration PBR removal trips, or to engage longer-term LCR removal trips, and from electrofishing operations in the Lees Ferry Reach (i.e. noise from boat motors and generators, and lights).

3.4.2.2 Recreational Boating under Proposed Action

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 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. 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

An important part of the recreational experience enjoyed by visitors to Grand Canyon National Park is the opportunity to be in a wilderness setting with minimal contact with other people and few sights and sounds associated with human activities. Non-native fish removal activities have the potential to disturb the wilderness experience for others, particularly those rafting the river, or hiking and camping near the river. These impacts include the noise and lights associated with removal actions, especially when they occur at night, the competition for camping sites along the river, and the simple presence of more people on the river.

The SDM Project analysis utilized an NPS metric for the purpose of evaluating non-native fish control methods. Penalized user-days per year in the GCNP wilderness during administrative trips were used to assess this affect, an NPS metric. Penalized user-days per year is calculated by using the staff size (number of people on a river trip administering science, in this case, non-native removal) multiplied by the number of days in the wilderness (this is the basic measure); this is adjusted by a penalty factor multiplier for activities that result in greater disturbance. Penalty factors include: boat (motor) user-days during motor season, penalty factor of 1 as a multiplier; boat (motor) user-days during non-motor season,

2; helicopter trips, 2; nighttime management activities, 3. Thus, for example, a 14-day removal trip with a staff of 8, conducted by boat during the non-motor season, with management activities primarily at night would have a score of 672 penalized user-days (14 days x 8 users x 2 [non-motor multiplier] x 3 [night multiplier]). If helicopter removal of live fish was required, with, say, 2 trips daily for 8 of the 14 days, an additional 32 penalized user-days (2 trips/day x 8 days x 2 [helicopter penalty multiplier]) would be added. The number of boats is not included in the calculation; presumably the number of users is tied to the number of boats. The proposed action scored poorly in this category, with 6,824 penalized-user days. This is understandable because of the amount of effort using motorized boats to remove non-native fish in two different areas of the parks.

Noise from outboard motors and gas generators would occur and the presence of researchers would add more people to the PBR reach and the LCR reach when removal activities are occurring. This alternative would result in direct, short-term, effects on wilderness character due to noise and visual intrusion. Despite the fact the SDM Project found that there would be disturbance effects to recreation from the proposed action in terms of increased disturbance, and that this effect would be substantial, these effects were minimal in terms of economic effects; in other words, the disturbance effects from the proposed action are not expected to affect the actual number of visitors to GCNP for wilderness or recreational rafter experiences.

The effects would be different for the PBR reach than for the LCR reach. The PBR reach includes 4 miles of wilderness (50% of reach) while the LCR includes 100% wilderness. In addition, very little hiking and riverside camping occurs in the first 8 miles, and overnight camping is not permitted in the first 4 miles (to Navajo Bridge). The effects would be of moderate intensity for visitors camping in the LCR reach, and of minor intensity for visitors rafting in the PBR reach. Effects would be on wilderness character and experience and include intrusion to site, sound, and smell (gasoline), especially when these activities occur during the non-motorized boating season. Live removal in either reach will necessitate more boats and equipment use than would euthanizing fishes, and more activity of boats moving up and down the river, which will add to the disturbance effects described above, and disturbance effects would more noticeable during the non-motor season.

3.4.2.3 Net Economic Use Value of Recreation under Proposed Action

Angling in Glen Canyon National Recreation Area (Lees Ferry) provides economic benefits to local economies, particularly in the areas of Vermilion Cliffs, Page, and Flagstaff, Arizona, and Kanab and surrounding areas of southern Utah. These economic and social benefits are to both small rural communities and to the region. A number of businesses (lodges, restaurants, guides, outfitters, and others) and individuals derive their income from anglers who have come to Marble Canyon for the fishing experience. Economic benefits are associated with factors such as the number of days anglers visit the area, and the number of white water rafting trips that occur in a given year.

A key aspect of economic benefits from visitation to the area is associated with wilderness and park experiences. Grand Canyon National Park provides benefits to both local and regional economies, and, with regard to non-native fish control, businesses that could be affected such as those associated with wilderness recreation that originates at Lees Ferry,

such as recreational rafting. Non-native fish control would affect the experience of wilderness recreation, but in the SDM Project, the affect of disturbance from removal activities of the proposed action was not anticipated to affect the economic value derived from recreational rafting.

The proposed action would result in impacts to local economies resulting from effects, or perceived effects by the public, resulting from the disturbance to visitors to GCNRA or GCNP to fish, hike, boat, or otherwise recreate in these parks. In the SDM Project, although substantial disturbance effects to boaters were recognized, this was estimated to have no effect on the contribution of white water rafting to local and regional economies.

The effect of the proposed action on the contribution of fishing in the Lees Ferry area is less clear. The proposed action is not anticipated to have an effect on the fishery itself, but would, as described in previous sections, result in disturbance effects to local anglers. This could result in less fishing activity in Lees Ferry, although this seems unlikely, given that there is some distance between the PBR reach and areas commonly fished in Lees Ferry. However, if fishing user days are affected, this could negatively affect local businesses that benefit from fishing in Lees Ferry, the fishing guides, local area businesses, and the Navajo Nation vendors. The local fishing guides informed Recreation that they believe their business has been affected directly by Reclamation's actions in the past (predominantly flow manipulations associated with HFEs). Data provided by the guides do indicate that their business has diminished in recent years (Figure 9). But nationwide economic conditions also may have contributed to this decline. Conversely, removing fish in the PBR reach, if it reduces abundances in the Lees Ferry reach, could improve the quality of the Lees Ferry fishery by creating a fishery with fewer but larger, healthier fish. This could positively affect local businesses if the improvement in the fishery results in more anglers visiting the area.

Local businesses in the Marble Canyon area may also benefit from increased business resulting from researchers and technicians working in the PBR reach to remove non-native fish, as these individuals would likely use lodging in the area, eat meals at local restaurants, and purchase fuel and equipment in local stores.

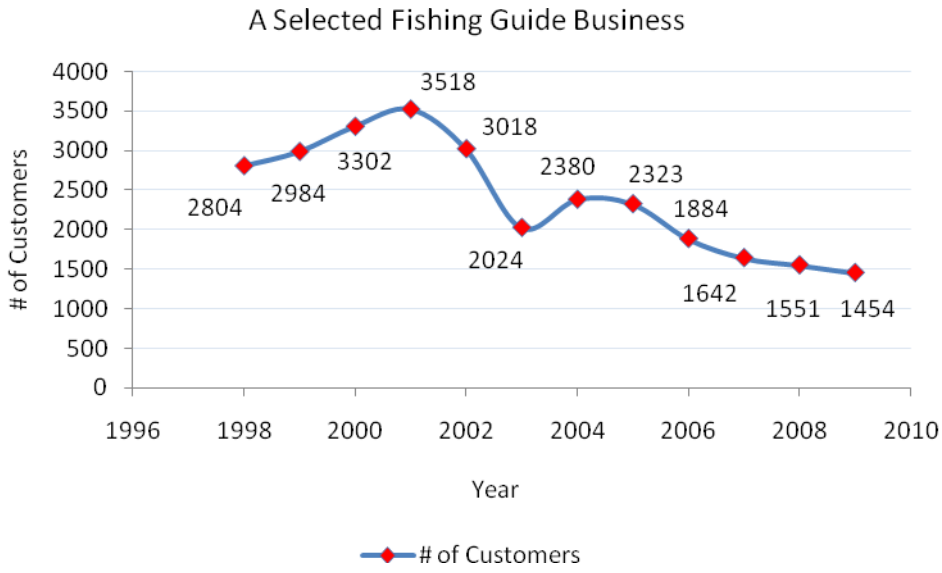

Figure 9. Numbers of anglers served by one fishing guide business.

3.4.2.4 Nonuse Economic Value under Proposed Action

There are different possible outcomes in terms of nonuse on values from the proposed action that are difficult to predict. If the public at large values the improvement in the native ecosystem that the non-native fish control would likely bring about, then nonuse values could benefit. This seems plausible, given that the natural beauty and native wilderness are values for which GCNP and GLNRA were established, and NPS management policies support removing non-native fish from the GCNP.

The Hopi Tribe believes that its cultural values for the Grand Canyon should be considered within the Western analysis framework as non-use values. Management actions that occur there can have effects at Hopi that do not depend on whether Hopi people enter (use) the Grand Canyon or not. The proposed action would have effects to Hopi non-use values as described in section 3.3.

3.5 *Indian Trust Assets*

Indian trust assets are legal interests in property held in trust by the US government for Indian tribes or individuals. Examples of such resources are lands, minerals, or water rights. The action area is bounded on the east by the Navajo Indian Reservation and on the south in part by the Hualapai Indian Reservation and the Havasupai Indian Reservation. Reservation land is a trust asset.

3.5.1 *Indian Trust Assets under No Action*

Reclamation has ongoing consultation with these tribes regarding potential effects of the proposed action on their trust assets. The no action alternative would have no effect on Indian trust assets.

3.5.2 *Indian Trust Assets under the Proposed Action*

The proposed action, with its focus on the Colorado River itself and on lands managed by the NPS would not impact Indian lands, minerals, or water rights. There is a possibility that the related science plan and future monitoring efforts would require access to Navajo Nation lands, particularly those in the LCR. All necessary consultations, permits and permissions would be obtained from the BIA and Navajo Nation prior to undertaking any work on Navajo lands.

3.6 *Wild and Scenic Rivers*

Wild and scenic rivers were not noted as an evaluation need during development of this EA, but is considered here as an issue per 16 USC 1271 and 40 CFR 1508.27(b)(3). The Wild and Scenic Rivers Act of 1969 calls for preservation and protection of free-flowing rivers. Pursuant to §5(d) of the Wild and Scenic Rivers Act, the NPS maintains a nationwide inventory of river segments that potentially qualify as wild, scenic, or recreational rivers. Within the action area, overlapping study segments have been proposed: (1) from the Paria Riffle (RM 1) to 237-Mile Rapid in Grand Canyon, and (2) from Glen Canyon Dam (RM -15) to Lake Mead. Grand Canyon National Park (National Park Service 1995, 2005b:18) acknowledges that the Colorado River meets the criteria for designation under the Wild and Scenic Rivers Act as part of the nationwide system; however, formal study and designation have not been completed.

3.7 *Wilderness*

Pursuant to the 1964 Wilderness Act, Grand Canyon National Park was evaluated for wilderness suitability. After the park was enlarged in 1975, Grand Canyon's Wilderness Recommendation was updated following a study of the new park lands. The most recent update of Grand Canyon's Wilderness Recommendation occurred in 2010 and recommended Wilderness designation for approximately 94 percent of the park. In accordance with NPS Management Policies, these areas are managed in the same manner as designated wilderness, and the NPS will take no action to diminish wilderness suitability while awaiting the legislative process.

The issue of effects to wilderness was evaluated in the SDM Project. The analysis for wilderness experience in this EA is contained in section 3.12.2 above. In addition to a wilderness experience as defined by the Wilderness Act as "outstanding opportunities for solitude or a primitive and unconfined type of experience," the Act also defines wilderness character as "untrammeled," undeveloped land retaining its "undeveloped land retaining primeval character in influence without permanent improvements or human habitation.

The No Action will continue to have a long-term adverse impact to wilderness character by allowing non-native populations to increase and as endangered populations decline.

The Proposed Action would have varying effects on other qualities and characteristics of wilderness depending upon implementation in the PBR or LCR. These would be of similar

intensity described in 3.12.2 for wilderness character, but overall the proposed action would be expected to have long-term beneficial effects to wilderness if native fish species are protected.

3.8 *Environmental Justice Implications under No Action*

Environmental justice refers to those issues resulting from a proposed action that disproportionately affects minority or low-income populations. To implement Executive Order 12898, *Environmental Justice in Minority Populations and Low Income Populations*, the Council on Environmental Quality (1997) instructs agencies to determine whether minority or low-income populations or Indian tribes might be affected by a proposed action, and if so, whether there might be disproportionate high and adverse human health or environmental effects on them. There would be no Environmental Justice impacts from the no action alternative.

3.9 *Environmental Justice Implications under the Proposed Action*

Coconino County Arizona has a disproportionate number of low income populations per the 2000 U.S. Census data. Reviewing each of the resources affected by the proposed action, there would be no human health effects. There would be environmental effects but these would not be disproportionally high and adverse with one exception. American Indian tribes consider the proposed action to have a substantial effect on their sacred sites and traditional cultural properties. Also, the local Navajo community, especially those living in the Bodeway-Gap Chapter, uses trout as a subsistence resource. Removal of trout could result in a reduction in catch rates in portions of the action area. Alternatively, removal of trout may also improve the overall fishery by improving population dynamics of the population, and increasing the number of larger healthier trout. Regardless, these impacts would occur to all anglers equally, thus not resulting in a high and disproportionate adverse effect to minority populations. We do not anticipate any other Environmental Justice impacts from the proposed action.

4.0 Consultation and Coordination

The 1995 EIS and 1996 Record of Decision called for an adaptive management approach to the management of the dam and powerplant. Since then, monitoring and research has substantially increased knowledge of the effects of dam operations on resources downstream in GCNP and GCNRA, including knowledge of effects to native and non-native fishes in the Colorado River downstream from the dam. Pursuant to the Grand Canyon Protection Act, the Colorado River Storage Project Act, and the other federal laws and regulations, this new EA should add to this knowledge and understanding.

4.1 *Consultation*

Tribal consultations on a government-to-government basis are ongoing and will be completed before a decision notice is completed for the proposed action.

4.2 *Public Scoping Activities*

Based on the previous experiments and before beginning preparation of this EA, a wide variety of people were contacted to get their ideas and concerns about the status of endangered fish in the Colorado River and possible treatments to reduce numbers of non-native fish, as well as the anticipated effects of these treatments. The Grand Canyon Monitoring and Research Center convened and conducted a Non-native Fish Workshop on March 30-31, 2010, to: (1) Describe non-native fish management in Grand Canyon, (2) identify critical issues and develop approaches to these issues, describe American Indian perspectives on management of native and non-native fish species, and (3) describe agency roles for non-native control in conservation and recovery of native fish in Grand Canyon. An integrated modeling workshop held April 14-15, 2010 and on October 12-15, 2010 helped to clarify the role of trout predation on the humpback chub and preliminarily identified possible strategies and treatments for managing trout populations in Grand Canyon. Reclamation also held meetings with flyfishing guides regarding the proposal on March 20, August 20, and December 20, 2010. Reclamation and the USGS also conducted a Structured Decision Making Project with two workshops, October 18-20 and November 8-10, 2010.

The draft EA was published on January 28, 2011 for a 30-day public review and comment period. In response to requests from the interested public, the comment period was extended to March 18, 2011. Thirty-five comment letters or emails were received and were fully considered in making revisions to the draft EA. This revised draft EA was circulated again for a two-week public review and comment on July 5, 2011 in order to provide the interested public the opportunity to review revisions to the previously published draft EA; this public comment period closed on July 26, 2011. There were 15 public comments received during the second comment period which were fully considered in making revisions to the final EA.

4.3 *Agency Cooperation*

Table 6. List of persons, agencies, and organizations consulted for purposes of this EA.

Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
Arizona Game & Fish	Consult with AZGFD as agency with expertise on fish and game species.	Data and analyses with respect to trout, fish, aquatic ecosystems, angler use, angler regulations.
Arizona State Historic Preservation Officer	Consult for undertaking, as required by NHPA (16 USC 470).	Concurrence with findings on eligibility and adverse effect under NHPA.
Bodeway-Gap Chapter of the Navajo Nation	Minority community for environmental justice and economic effects.	Data on effects to local economies and tribes.
Bureau of Indian Affairs	Consult with BIA over Indian trust assets and other American Indian tribal concerns.	Adverse effect under EO 13007.
Coconino County	Air quality data and concerns with economics and environmental justice.	Data on impacts to local economies.
Hualapai Indian Tribe	Consult regarding land and resource effects, consult with THPO over NHPA.	Information on impacts to cultural resources and local economies.
Kaibab Band of Paiute Indians	Consultation as required by the American Indian Religious Freedom Act of 1978 (42 USC 1531) and NHPA (16 USC 1531) and EO 13007.	Information on impacts to cultural resources.
Marble Canyon and Lees Ferry Community	Recreational and economic effects.	Data on impacts to local economies.
National Park Service	Land managing agency for GLCA and GRNP.	Data on visitor use and related impacts in GCNP and GCNRA.
Navajo Nation	Consult regarding land and resource effects, consult with THPO over NHPA. Project might require permits to access land.	Information on impacts to cultural resources and local economies.
Paiute Indian Tribe of Utah	Consultation as required by the American Indian Religious Freedom Act of 1978 (42 USC 1531) and NHPA (16 USC 1531) and EO 13007.	Information on impacts to cultural resources.
Pueblo of Zuni	Consultation as required by the American Indian Religious Freedom Act of 1978 (42 USC 1531) and NHPA (16 USC 1531) and EO 13007.	Information on impacts to cultural resources.
U.S. Geological Survey	Information regarding resources. Figure 1, science plans provided.	Data and analysis on biological, physical, cultural resources.
U.S. Fish and Wildlife Service	Consult with USFWS as an agency with expertise on fish and wildlife resources, including endangered species, under the ESA.	Data and analysis with respect to aquatic ecosystem and ESA compliance, final biological opinion on action.
Western Area Power Administration	Information regarding hydropower and environmental justice.	Data on impacts to hydropower.

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6.0 APPENDICES

Appendix A: Non-native Fish Management below the Glen Canyon Dam Report from a Structured Decision Making Project

Appendix B: Science Plan

Appendix C: Biological Assessment

Appendix D: Supplement to Biological Assessment

Appendix E: Biological Opinion

Appendix F: Letter to State Historic Preservation Office with Concurrence Stamp