National Park Service
U.S. Department of the Interior

Grand Canyon National Park
Glen Canyon National Recreation Area

Comprehensive Fisheries Management Plan

Environmental Assessment

Cover Photos

Havasu Creek, Grand Canyon National Park.

Inset: Translocated humpback chub, captured in Havasu Creek during post-translocation monitoring, 2011.

Photos by Amy S. Martin/NPS.

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May 2013

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UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

ENVIRONMENTAL ASSESSMENT COMPREHENSIVE FISHERIES MANAGEMENT PLAN GRAND CANYON NATIONAL PARK GLEN CANYON NATIONAL RECREATION AREA COCONINO COUNTY, ARIZONA

ABSTRACT

The National Park Service (NPS) proposes to implement a Comprehensive Fisheries Management Plan (CFMP), in coordination with the Arizona Game and Fish Department (AZGFD), the U. S. Fish and Wildlife Service (USFWS), U.S. Bureau of Reclamation (USBR) and the USGS-Grand Canyon Monitoring and Research Center (USGS-GCMRC), as described in this Environmental Assessment (EA) for all fish-bearing waters in Grand Canyon National Park (GCNP) and Glen Canyon National Recreation Area (GCNRA) below Glen Canyon Dam (GCD; see Maps 1.1 and 1.2). The intent of the Comprehensive Fish Management Plan is to maintain

- a thriving native fish community within Grand Canyon National Park
- a highly valued recreational trout fishery in the Glen Canyon Reach[1] (see Map 1.2) and

The plan provides the framework for a fisheries management program and includes a No Action and two Action Alternatives.

Background

Prior to the completion of GCD in 1963, the Colorado River and its tributaries were home to eight native fish species. The river carried high sediment loads, and river flows and water temperatures varied tremendously by season. Since dam completion, released water has been clear and cold with flow variations based on watershed precipitation cycles (tributary inflows) and water storage and electrical generation needs. Non-native fish introduction, water diversions, and other factors also altered native fish habitats. Effects of these impacts have resulted in extirpation of three native fish species from GCNP and GCNRA including two listed under the Endangered Species Act (ESA), the Colorado pikeminnow and bonytail, and one candidate species, the roundtail chub. Two other native fish species, the humpback chub (HBC) and razorback sucker, are currently present in GCNP but listed as federally endangered. Only speckled dace, flannelmouth sucker, and bluehead sucker still maintain healthy populations, mainly in GCNP (see Appendix A). The tailwater below in GCNRA below GCD does not provide suitable habitat for native fish populations. A non-native trout fishery was established in the Glen Canyon Reach in the 1960s[2]. This fishery has become important to both anglers and local businesses that cater to anglers. For more information on GCNRA's Rainbow Trout Fishery, see Chapter 3, Affected Environment, Fisheries, Historical Status 1964-1998.

NPS Fisheries Management Goals

Plan goals differ between GCNRA and GCNP, reflecting differences management objectives and habitat conditions immediately below GCD and down river.

GCNP fisheries management[3] goals for the Colorado River and its tributaries in GCNP are

1. Meet or exceed population and demographic goals for the appropriate GCNP recovery unit (see Glossary) for existing Endangered Species Act (ESA) listed fish species, maintain self-sustaining populations, and restore distribution of those species to the extent practicable

[1] For purposes of this CFMP EA, the Glen Canyon Reach is defined as the 15-miles downstream from GCD on the Colorado River in GCNRA, including Lees Ferry and the mouth of the Paria River (see Map 1.2)
[2] http://www.gcmrc.gov/research_areas/rainbow_trout/rainbow_trout_default.aspx
[3] Additional information about GCNP fisheries management is available at www.nps.gov/grca/naturescience/fish.htm

2. Maintain or enhance viable populations of existing native fish and restore native fish communities and native fish habitat in GCNP to the extent practicable
3. Restore self-sustaining populations of extirpated fish species including Colorado pikeminnow, razorback sucker, bonytail, and roundtail chub as appropriate and to the extent feasible (if feasibility studies determine each species can be reasonably restored without impacting existing ESA-listed species)
4. Foster meaningful tribal relations and integrate tribal knowledge and perspectives into park management decisions and practice
5. Prevent further introductions of non-native (exotic) aquatic species, and remove, when possible, or otherwise contain, individuals or populations of non-native species already established in GCNP

GCNRA long-term (20-year) fisheries management[4] goals for the Colorado and Paria Rivers in GCNRA are

1. Maintain a highly valued recreational rainbow trout fishery with minimal emigration of rainbow trout downstream to Grand Canyon National Park
2. Restore and maintain healthy, self-sustaining native fish communities; native fish habitat; and the important ecological role of native fish to the extent possible
3. Foster meaningful tribal relations and integrate tribal knowledge and perspectives into park management decisions and practices
4. Prevent further introductions of non-native (exotic) species

This CFMP EA has been prepared in compliance with the National Environmental Policy Act and other federal and state laws, regulations, and policies described below. It will provide a decision-making framework to

- analyze a reasonable range of Alternatives to meet project objectives
- evaluate potential issues and impacts to resources and values
- identify mitigation measures to lessen degree or extent of these impacts
- describe an adaptive management framework for management decisions over the life of the plan: up to 20 years or until a new plan is completed

Impact Topics Retained for Analysis

- Fisheries
- Ethnographic Resources
- Visitor Use and Experience
- Wilderness Character
- Non-Fish Special Status Species

Alternatives

Alternative 1 No Action
Continues current management actions and does not meet goals and objects described in this EA.

Alternative 2 Moderate Intensity Fisheries Management NPS Preferred
Alternative 2 includes implementation of conservation measures for endangered fish species, but also addresses issues raised by Traditionally Associated American Indian Tribes and some anglers related to euthanizing non-native fish species, and involves moderate intensity management actions and less mechanical control of non-native fish than Alternative 3.

Alternative 3 Intensive Fisheries Management
This Alternative also includes implementation of conservation measures, but emphasizes a proactive approach to control of non-native species in GCNP to limit risk of impacts to native species, including endangered fish species.

None of the three Alternatives analyzed would have more than moderate impacts to the environmental setting including wetlands; vegetation; water quality and quantity; fish and wildlife resources including special status species; social and economic resources; recreational fishing; ethnographic and cultural resources; health and human

[4] For information on GCNRA's trout fishery in the Glen Canyon Reach visit: http://www.gcdamp.gov/keyresc/tf.html

safety; visitor use and experience; park operations; and Wilderness Character and experience. Alternative 2, the Preferred Alternative, would result in both short- and long-term adverse and beneficial impacts to these resources and would not result in impairment of park resources.

Public Comment

The public comment period for the EA is May 9 to June 10, 2013. If you wish to comment on the EA, the NPS prefers comments be posted online to the Planning, Environment, and Public Comment (PEPC) site http://parkplanning.nps.gov/GCNP. Alternatively, comments can be hand-delivered to the park's headquarters in Grand Canyon, Arizona or mailed to

Superintendent
Grand Canyon National Park
Attn: Comprehensive Fisheries Management Plan EA
P.O. Box 129
Grand Canyon, Arizona 86023-0129

Be aware that your entire comment—including your address, phone number, email, and other personal identifying information—may be made publicly available at any time. Although you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee we will be able to do so.

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CHAPTER 1 PURPOSE AND NEED

The National Park Service (NPS) proposes to implement a Comprehensive Fisheries Management Plan (CFMP) as described in this Environmental Assessment (EA), in coordination with the Arizona Game and Fish Department (AZGFD), the U.S. Fish and Wildlife Service (USFWS), the U.S. Bureau of Reclamation (USBR), and the USGS-Grand Canyon Monitoring and Research Center (USGS-GCMRC), for all fish-bearing waters in Grand Canyon National Park (GCNP) and Glen Canyon National Recreation Area (GCNRA) below Glen Canyon Dam (GCD) (see Maps 1.1 and 1.2). The intent of the Comprehensive Fisheries Management Plan is to maintain

- a highly valued recreational trout fishery in the Glen Canyon Reach[5] (see Map 1.2) and
- a thriving native fish community within Grand Canyon National Park

This EA analyzes a fisheries management program for GCNP and GCNRA and includes a No Action and two Action Alternatives.

INTRODUCTION

The Colorado River flows through 15 miles (24 km) of Glen Canyon National Recreation Area downstream of GCD before entering Grand Canyon National Park where it flows for another 277 miles (446 km) until it reaches Lake Mead. The Colorado River and its tributaries in GCNP and GCNRA were once home to eight species of native fish. Prior to GCD closure in 1963, the river carried high sediment loads and, depending on season, flows and water temperatures varied widely. Following dam construction, released water has been cold and clear with variations in flow based on flood control, water storage, and power generation needs. Colorado River tributaries have natural flow and temperature regimes conducive to native fish spawning and rearing.

However, introduction of non-native fish species, both intentional and accidental, has affected native fish in the Colorado River and its tributaries downstream of GCD. Cold- and/or warm-water non-native fish exist in all fish-bearing waters in GCNP and GCNRA below GCD. These species can dominate the fish community in some areas and may threaten native species survival. Nevertheless, habitats in the Colorado River and its tributaries in GCNP support the largest remaining endangered humpback chub (HBC) population.

Of the eight native species once found in the Colorado River and its tributaries, three species—the **Colorado pikeminnow** (*Ptychocheilus lucius*), **bonytail** (*Gila elegans*) and **roundtail chub** (*Gila robusta*)—are extirpated from GCNP and GCNRA. The Colorado pikeminnow and bonytail are federally listed under the Endangered Species Act (ESA) as endangered; the roundtail chub is a candidate for listing as a Discrete Population Segment in Arizona and part of New Mexico. Bonytail populations persist from hatchery stock, and are functionally extinct in the wild (USFWS 2012).

Two other federally endangered native fish, **humpback chub** (*Gila cypha*) and **razorback sucker** (*Xyrauchen texanus*), are present in GCNP. Although previously considered extirpated (Valdez and Carothers 1998), four sonic-tagged adult razorback sucker were detected in GCNP in 2012 (Kegerries unpublished data), and a single adult male razorback sucker was captured during routine GCNP surveys October 2012 (Bunch personal communication).

[5] For purposes of this CFMP EA, the Glen Canyon Reach is defined as the 15-miles downstream from GCD on the Colorado River in GCNRA, including Lees Ferry and the mouth of the Paria River (see Map 1.2)

Additional native species that persist in the project area include **flannelmouth sucker** (*Catostomus latipinnis*), **bluehead sucker** (*Catostomus discobolus*), and **speckled dace** (*Rhinichthys osculus*) (see Appendix A).

BACKGROUND

Glen Canyon Dam (GCD) Background

Prior to GCD completion in 1963, the Colorado River and tributaries were home to eight native fish species. The river carried high sediment loads, and flows and water temperatures varied tremendously by season. Since dam completion, released water has been clear and cold with flow variations based on watershed precipitation cycles (tributary inflows) and water storage and electrical generation needs. Non-native fish introduction, water diversions, and other factors also altered native fish habitats. These impacts resulted in extirpation of three native fish species from GCNP and GCNRA including two endangered species, the Colorado pikeminnow and bonytail, and one candidate species, the roundtail chub. Two other native fish species, humpback chub and razorback sucker, are currently present in GCNP but listed as endangered. Only speckled dace, flannelmouth sucker, and bluehead sucker still maintain healthy populations, mainly in GCNP. A non-native trout fishery, established in the Glen Canyon Reach in the 1960s[6], has become important to both anglers and local businesses. For more information on GCNRA's Rainbow Trout Fishery, see Chapter 3, Affected Environment, Fisheries, Historical Status 1964-1998.

GCD water releases control timing, magnitude, and duration of Colorado River flows. GCD is operated in accordance with criteria and operating plans specified in the **1992 Grand Canyon Protection Act's** section 1804 and in compliance with the other laws cited in that Act. GCPA directs the Secretary of the Interior to

> "…operate GCD 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."

GCD forever changed the ecology of the Colorado River as it flows through GCNRA and GCNP: the biggest change being the aquatic system. Recent Biological Opinions (USFWS 2008, 2011) on GCD operations or coordinated reservoir operations for Lake Mead and Lake Powell (USFWS 2007) mandated several conservation or reasonable and prudent measures to mitigate risks to humpback chub and razorback sucker in Grand Canyon. These mandates to partially offset the impacts of GCD operations upon ESA-listed species drove the development of the CFMP. Conservation measures analyzed in the CFMP EA include: 1) humpback chub translocations to tributaries outside the Little Colorado River, and associated monitoring; 2) expanded brown trout control around Bright Angel Creek; 3) non-native fish control in tributaries and the mainstem (Colorado River); 4) mainstem humpback chub aggregation conservation; and 5) habitat evaluation and augmentation or management plan development for razorback sucker in western areas of GCNP in the Colorado River.

Under the 2008 Biological Opinion for GCD operations (USFWS 2008), USBR committed to establish humpback chub population redundancy in GCNP tributaries outside of the Little Colorado River. Since 2009, NPS, in cooperation with USBR, USFWS, AZGFD[7], and GCMRC translocated

[6] http://www.gcmrc.gov/research_areas/rainbow_trout/rainbow_trout_default.aspx

[7] In GCNP and GCNRA state law applies to fish management, but only to the extent not preempted by federal statute, regulation, or lawful administrative action. In accordance with CFR part 24, NPS must consult with AZGFD before taking certain administrative actions to manage fish in park units

humpback chub to GCNP tributaries outside the Little Colorado River, to fulfill, in part, USBR commitment. Concurrent with these efforts, NPS has initiated non-native trout (brown and rainbow) removals in tributaries prior to and following humpback chub translocations to improve translocated humpback chub survival.

Fisheries Management and Planning In GCNP and GCNRA Background

Grand Canyon National Park was established as a national monument in 1908 and a national park in 1919. Today, the park encompasses 1.2 million acres and was named one of the first World Heritage Sites in 1979 due to its scenic, geologic, biological significance, and its importance as an ecological refuge with relatively undisturbed remnants of dwindling ecosystems (such as boreal forest and desert riparian communities) and numerous endemic, rare or endangered plant and animal species.

Glen Canyon National Recreation Area, established in 1972, encompasses 1.25 million acres. GCNRA is located on the Colorado Plateau, provides for public enjoyment through diverse land- and water-based recreational opportunities, and protects scenic, scientific, natural, and cultural resources on Lake Powell, the Colorado River and its tributaries and surrounding lands.

The U.S. Forest Service, federal land manager for the area prior to NPS creation in 1916, conducted the first known introductions of non-native fish in GCNP tributaries for a number of years prior to national park creation (Williamson and Tyler 1932). After park establishment, NPS introduced various trout species (brook trout, *Salvelinus fontinalis*; rainbow trout and brown trout) into Bright Angel Creek and other tributaries numerous times between 1920 and 1964 (Haden 1992).

Stocking of non-native fish ceased in GCNP after 1972, but AZGFD continued to stock rainbow trout in the Glen Canyon Reach until 1998. According to Sellars (1997), during the years non-native species were stocked in NPS waters, federal agencies were responding to prevailing social values and public demand by giving sport fishing a higher priority than preservation of native aquatic communities. This management practice was acknowledged in the 1930s to be an "important exception to general [NPS] policy," citing that "recreational benefits" overruled biological "disadvantages which are incidentally incurred" (Wright et al. 1933 cited in Sellars 1997). Social values began to shift in the mid-twentieth century as the scientific community, the public, and government agencies increasingly understood that introduced species could disrupt entire ecosystems and lead to decline and extinction of native species.

Reflecting the growing public understanding and appreciation of ecological values, the NPS became increasingly reluctant to make an "exception to general policy" when it came to introducing sport fish in national parks. That "general policy" was, and is, rooted in the NPS Organic Act of 1916, the NPS founding legislation. As stated in NPS Director's Order 55*, Interpreting the NPS Organic Act (2000), courts interpreting the Organic Act have consistently ruled that "when there is a conflict between conserving resources and values and providing for the enjoyment of them, conservation is to be predominant."

NPS management objectives and practices now favor preserving native fish communities over non-native sport fisheries where exotic species are not maintained to meet an identified park purpose. GCNP's Fish Management Plan (1981), referencing the NPS Management Policies Handbook (1978), stated management of fish resources shall be "Specifically aimed toward preservation or restoration of the full spectrum of native species, including fish" and "no artificial stocking of exotic fish species will occur; artificial stocking of fish may be employed only to re-establish native species." The GCNP Resource Management Plan (1997) identifies the threat posed by non-native

species to park wildlife resources as a major issue, and states "in cases where funding and personnel levels allow and where success is likely, control measures will reduce alien species populations."

GCNRA's enabling legislation permits fishing in the Glen Canyon Reach in accordance with U.S. and Arizona laws, except the NPS "may designate zones where and establish periods when, no hunting, fishing, or trapping shall be permitted for reasons of public safety, administration, or public use and enjoyment." "Expect in emergencies, any regulation of the Secretary pursuant to this section shall be put into effect only after consultation with the appropriate State fish and game department" (43 C.F. R Part 24). Fishing regulations for the Glen Canyon Reach are developed in consultation between NPS and AZGFD.

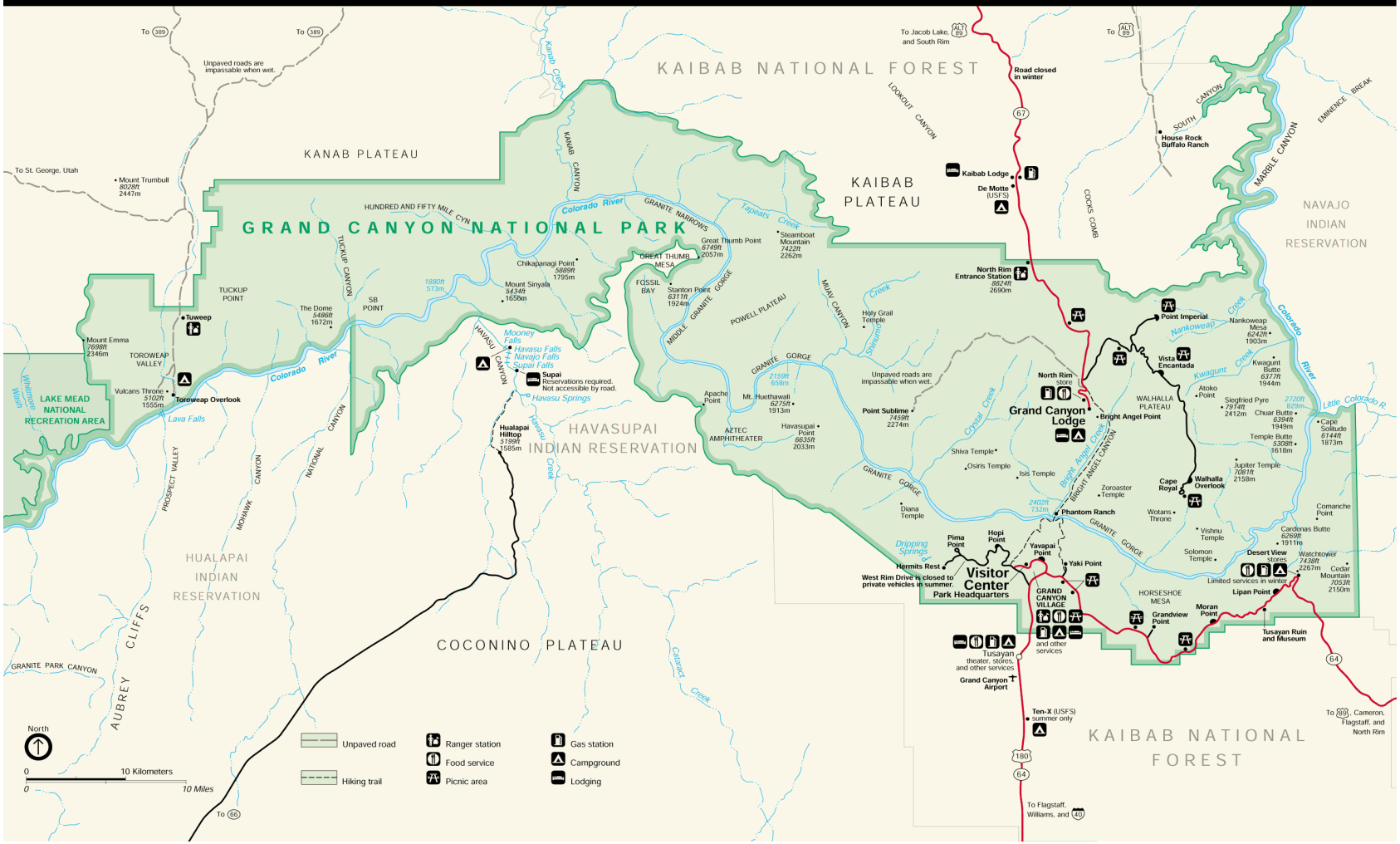
AZGFD, which collaborated on CFMP development, has developed the Glen Canyon Reach trout fishing since 1964. CFMP goals are consistent with those developed by AZGFD to

- Maintain, manage, and enhance the quality, abundance, availability, and diversity of sport fish opportunities while contributing to the conservation of Arizona's native fish
- Develop integrated, watershed-based fisheries management approaches for watersheds and identify reaches or zones for management for sport fish and native fish
- Increase public awareness of Arizona's sport fishing resources and opportunities
- Develop and implement actions to increase angler recruitment and retention

In 1996, GCNRA and AZGFD jointly developed a Fish Management Plan that covered the Glen Canyon Reach trout fishery. This plan incorporated the missions of the NPS and the State of Arizona in relation to fishery resources management.

Fundamental to the 1996 plan was the belief that with proper management and planning, GCNRA can provide for an outstanding recreational sport fishery and native fish species preservation. Glen Canyon Reach 1996 plan goals vary little from CFMP goals. The 1996 plan also provided a framework for resource managers to meet and discuss issues, identify roles, establish protocols, and resolve conflicts, while expanding expertise and resources available to each agency. The 1996 plan identified issues, goals, and objectives related to fish. This CFMP updates fisheries management goals for the Glen Canyon Reach.

Map 1.1 Grand Canyon National Park and Vicinity, and GCNP Project Area

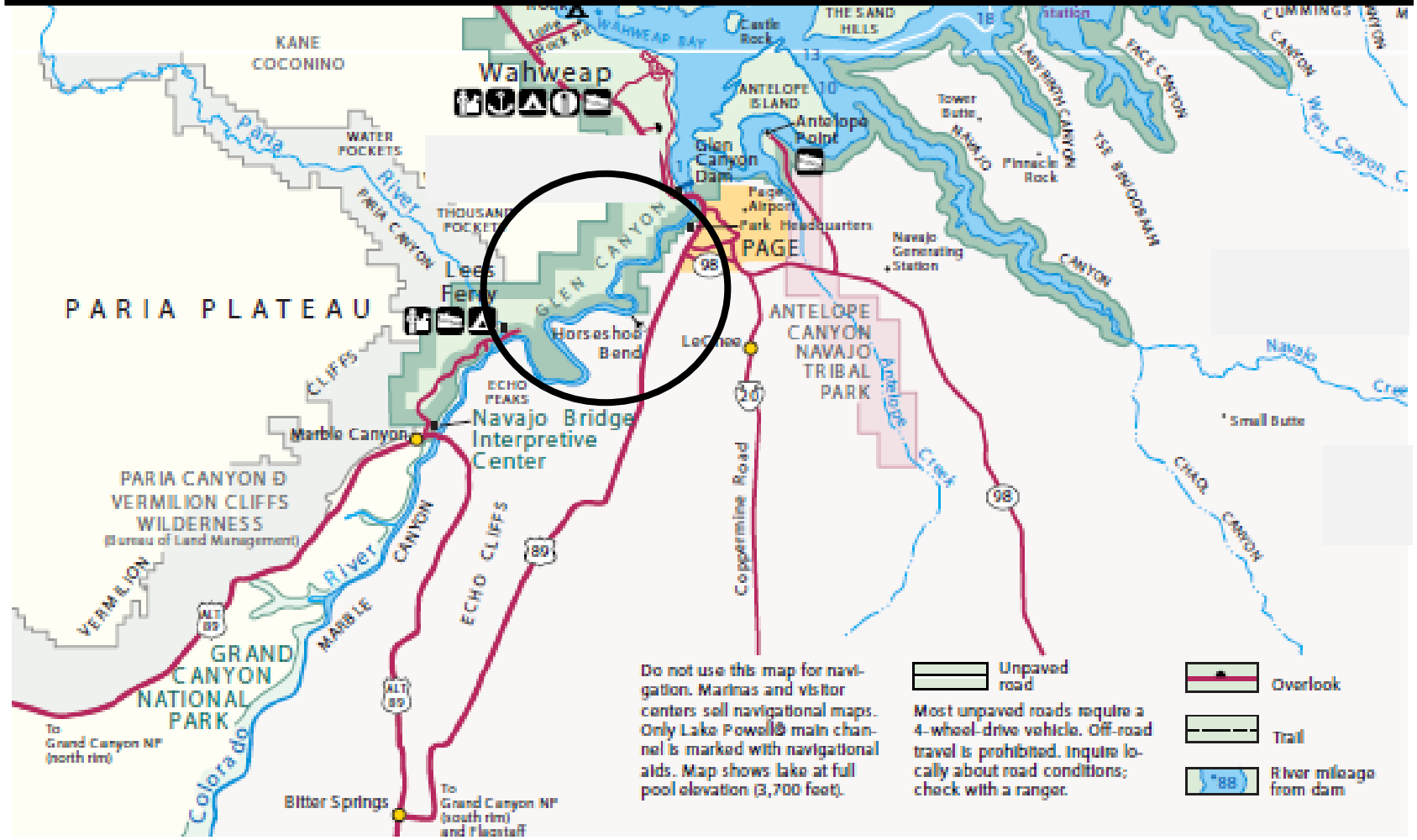


SCOPE OF ANALYSIS

Project Area

The scope of this plan includes all waters between Glen Canyon Dam and Lake Mead including the Colorado River and its tributaries in GCNP (see Map 1.1), and the Glen Canyon Reach of the Colorado and Paria Rivers in GCNRA (see Map 1.2). Specific Fish Management Zones are described in Table 1.1.

Map 1.2 The Glen Canyon Reach in Glen Canyon National Recreation Area



Time Frame **Scope of Analysis**
This EA analyzes conditions for a 20-year period.

PURPOSE OF AND NEED FOR ACTION

Purpose **Purpose and Need**
The purpose of this CFMP EA is to analyze an adaptive, programmatic framework for meeting fisheries management goals and objectives in the Colorado River and its tributaries in GCNP and in the Glen Canyon Reach of GCNRA. The CFMP EA supports conservation and recovery of native fish communities including threatened and endangered species, USFWS-mandated Recovery Goals (see Appendix B), and establish management direction for the Glen Canyon Reach recreational rainbow trout fishery. Due to uncertainties in future dam operations and changing habitat conditions, an adaptive management strategy is proposed to implement fisheries management actions to meet fisheries goals and objectives.

Need **Purpose and Need**
The CFMP is needed to manage fish communities in GCNP and GCNRA substantially altered by human actions through GCD construction and operation and introduction of non-native fish species, and to implement conservation measures developed between USBR and USFWS related to GCD (USFWS 2011) and Lake Powell and Lake Mead coordinated reservoir operations (USFWS 2007). GCNP conservation measures include

1) translocations of humpback chub to tributaries outside the Little Colorado River, and associated monitoring
2) expanded brown trout control around Bright Angel Creek
3) non-native fish control in tributaries and the mainstem Colorado
4) conservation of mainstem Colorado humpback chub aggregations
5) habitat evaluation and augmentation or management plan development for razorback sucker below Lava Falls (River Mile [RM] 179.2)

In addition, the NPS is a signatory on an interagency range-wide conservation agreement and strategy for flannelmouth and bluehead suckers (Utah Division of Wildlife Resources 2006) found in the project area.

Some Colorado River tributaries have natural flow and temperature regimes conducive to native fish spawning and rearing. However, GCD construction and operation resulted in an altered thermal regime, with both colder- and warmer-than-natural seasonal water temperatures in the Colorado River, limiting native fish ability to reproduce outside tributaries. Native fish are rare in or absent from (depending on species) the Colorado River in GCNRA, and at this time only five of eight native fish species are found in the project area. The CFMP would identify, prioritize, and guide implementation of management actions that protect and restore native fish communities, and make progress toward recovery of fish species in GCNP listed under the Endangered Species Act (ESA). The CFMP is also needed to guide management of a rainbow trout fishery in GCNRA's Glen Canyon Reach to provide a highly valued rainbow trout fishery in a manner that does not unacceptably impact native fish populations.

Humpback chub and flannelmouth and bluehead sucker reproduction occurs primarily in the Little Colorado River. This single reproduction location puts native fish at risk because a single disturbance in the Little Colorado River watershed such as a disease outbreak, invasion of new non-native species, increased abundance of existing non-natives, or a chemical spill at a highway overpass outside the park could endanger the entire community. Establishing additional spawning humpback chub populations in other park areas while maintaining or enhancing existing populations of other native fish elsewhere in GCNP, would improve populations' resiliency. GCNP also may present unique opportunities to re-establish extirpated species.

Fisheries Management Mandates, Goals, Objectives, and Desired Conditions

Fisheries Management Mandates **Purpose and Need**

This Comprehensive Fisheries Management Plan EA analyses management direction for all fisheries management in the free-flowing portions of the Colorado River and its tributaries from GCD to Lake Mead, and in accordance with

- USFWS Biological Opinions (BO) (e.g. USFWS 2011) on GCD operations mandated specific or reasonable and prudent conservation measures to mitigate risks to both humpback chub and razorback sucker in GCNP
- USFWS Recovery[8] Plans for endangered species found in the project area
- NPS Management Policies (Section 4.4, NPS 2006a) provide specific direction to park managers and require active management for preserving native species and processes and removing or containing non-native species
- The NPS Mission which states, "the Service thus established shall promote and regulate the use of Federal areas known as national parks, monuments and reservations…by such means and measures as conform to the fundamental purpose of the said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

For further information see Chapter 1, Relationship to Other Plans and Policies.

Fisheries Management Goals **Purpose and Need**

Goals are statements of direction or intent for fisheries communities' management in the Glen Canyon Reach and throughout GCNP. Plan goals differ between GCNRA and GCNP, reflecting different management objectives and habitat conditions immediately below GCD and down river. Goals listed here are the basis for defining fisheries resources Desired Conditions listed in Chapter 1, Desired Conditions.

GCNP Fisheries Management Goals for the Colorado River and its Tributaries Purpose and Need

1. Meet or exceed population and demographic goals for the appropriate recovery unit applicable to GCNP for existing ESA-listed fish species, maintain self-sustaining populations, and restore distribution of those species to the extent practicable
2. Maintain or enhance viable populations of existing native fish, and restore native fish communities and native fish habitat to the extent practicable
3. Restore self-sustaining populations of extirpated fish species including Colorado pikeminnow, razorback sucker, bonytail, and roundtail chub as appropriate and to the extent feasible (if feasibility studies determine each species can be reasonably restored without impacting existing ESA-listed species)
4. Foster meaningful tribal relations and integrate tribal knowledge and perspectives into park management decisions and practices
5. Prevent further introductions of non-native (exotic) aquatic species, and remove, when possible, or otherwise contain individuals or populations of non-native species already established in GCNP

[8] What do we mean by recovery? Recovery is the process that stops the decline of an endangered or threatened species by removing or reducing threats. Recovery ensures long-term survival of a species in the wild. At that point, the species is recovered, and Endangered Species Act protection is no longer necessary. However, all native species remain protected within national parks. See Appendix B for more information on Recovery

GCNRA Fisheries Management Goals for the Colorado and Paria Rivers **Purpose and Need**

1. Maintain a highly valued recreational rainbow trout fishery with minimal emigration of rainbow trout downstream to GCNP
2. Restore and maintain healthy, self-sustaining native fish communities, native fish habitat, and the important ecological role of native fish to the extent possible
3. Foster meaningful tribal relations and integrate tribal knowledge and perspectives into park management decisions and practices
4. Prevent further introductions of non-native (exotic) aquatic species

Fisheries Management Objectives **Purpose and Need**

Measureable objectives are time-sensitive benchmarks used to determine whether progress is being made toward meeting broad goals and whether desired conditions are met. Objectives cover either the entire project area or a specific Fish Management Zone (FMZ)—areas with similar habitat conditions, suitability for native fish or sport fish (Glen Canyon Reach), and restoration potential (See Table 1.1). FMZ were established during a series of stakeholder workshops in 2010 (see Chapter 4), and in coordination with the AZGFD and USFWS in 2012, and are based on physical habitat (water temperature, turbidity); differences in existing fish communities; and presence of major tributaries. For example, the process of delineating tributary and tributary inflow zones was guided by known historic or current presence of humpback chub aggregations (Valdez and Ryel 1995). Throughout the life of the CFMP, measureable objectives listed below may be adjusted or adapted with results of new research and monitoring. The best available science may indicate necessary objective changes to meet long-term goals for fisheries resources in the project area, and lead to updates to this plan.

Table 1.1 CFMP Fish Management Zones

Fish Management Zone	Description/Location
Projectwide	All Waters
Glen Canyon Reach	Colorado River: GCD to Paria River including Lees Ferry
Marble Canyon Reach	Colorado River: Paria River to Kwagunt Rapid (RM 0 – 56)
Little Colorado River Inflow	Colorado River: Kwagunt Rapid to Tanner Rapid (RM 56 – 68.5)
Bright Angel Creek/Inflow	Bright Angel Creek watershed and Colorado River between Zoroaster and Horn Creek rapids (RM 84.7 – 90.2)
Shinumo Creek/Inflow	Shinumo Creek watershed and Colorado River between Bass and Shinumo Rapids (RM 107.7 – 108.6)
Havasu Creek/Inflow	Havasu Creek on NPS managed-lands, and the Colorado River between RM 155 and 157
Lower Colorado River	Colorado River between Lava Falls Rapid (RM 179.2) and Lake Mead
Colorado River	Colorado River throughout the Project Area (outside areas specifically included in other FMZ)

Projectwide Objectives ***Purpose and Need***

- Monitor for, and respond to, new invasions and/or expanded range or relative abundance of non-desirable fish or Aquatic Invasive Species (AIS) with feasible control measures
- Determine natal origin or introduction source of all warm-water (e.g., bass, catfish) and high-priority cold-water non-native species (e.g., brown trout); develop and implement plans to control sources
- Implement a beneficial use program for non-native species removed for the purpose of native fish community restoration or ESA-listed fish recovery consistent with NHPA Section 106 consultation with Traditionally Associated American Indian Tribes
- Conduct inventory of aquatic communities in tributaries where data are unavailable, and develop and implement restoration plans when necessary

- Implement a monitoring plan sufficient to assess changes in fish populations related to management actions or natural factors

GCNP Objectives ***Purpose and Need***

Little Colorado River Inflow FMZ Objectives

- Maintain adult abundance of humpback chub at or above the latest population estimate (6,000-10,000 adult HBC, Coggins and Walters 2009), or above the minimum viable population size, as determined by USFWS, whichever is greater
- Maintain stable or increasing populations of bluehead sucker, flannelmouth sucker, and speckled dace

Bright Angel Creek/Inflow FMZ Objectives

- Reduce and maintain abundance of non-native trout at approximately 20% of baseline, or less, over five years to allow for enhanced populations of native resident species
- Maintain stable or increasing populations of bluehead sucker, flannelmouth sucker, and speckled dace (i.e., existing native fish)
- Following reduction of non-native species (brown trout), begin experimental humpback chub translocations to establish spawning aggregation, with the mature population increasing toward the estimated carrying capacity in Bright Angel Creek or toward minimum viable population size in the Bright Angel Inflow Aggregation (see Glossary), while maintaining genetic integrity

Shinumo Creek/Inflow FMZ Objectives

- Over the next ten years, establish a spawning aggregation of humpback chub, with the mature population increasing toward the estimated carrying capacity in Shinumo Creek or toward minimum viable population size in the Shinumo Inflow Aggregation while maintaining genetic integrity
- Investigate alternative release techniques and management strategies to improve retention and rearing of translocated HBC in Shinumo Creek and other tributaries where translocation may occur
- Maintain stable or increasing populations of bluehead sucker and speckled dace

Havasu Creek/Inflow FMZ Objectives

- Over the next ten years, establish a spawning aggregation of humpback chub, with the mature population increasing toward Havasu Creek's estimated carrying capacity, or toward minimum viable population size in the Havasu Inflow Aggregation while maintaining genetic integrity
- Maintain stable or increasing populations of bluehead sucker, speckled dace, and other native species in Havasu Creek.

Lower Colorado River FMZ Objective

- Develop and implement a management strategy for razorback sucker coordinated with Lake Mead National Recreation Area (LAKE)

Colorado River FMZ Objectives

- Maintain stable or increasing populations of bluehead sucker, flannelmouth sucker, and speckled dace
- Evaluate potential for reintroducing native extirpated species and begin developing implementation strategies as practicable

GCNRA Objectives ***Purpose and Need***

Glen Canyon Reach FMZ Objectives

- Maintain angler catch rates of at least ten fish per day greater than 14 inches with an angler catch rate above one fish per hour
- On an annual basis, maintain proportion of rainbow trout less than six inches at 20-80% of the population, and maintain at least moderate condition of catchable rainbow trout size (greater than 12 inches)

- Maintain rainbow trout fishery representative of the range of age classes
- Promote take of all undesirable non-native fish by anglers including but not limited to brown trout, walleye, bass, and sunfish to prevent potential impacts to rainbow trout fishery and native fish populations

Desired Conditions **Purpose and Need**

A desired condition is a detailed, measurable description of what a resource will look like after achieving a management goal over the long term (i.e., 20 years). Desired Conditions for fisheries resources are what managers will strive to achieve over the long term, and are critical to developing more specific, time-limited objectives for projects or programs implemented through the CFMP.

Project Area Fisheries Desired Conditions ***Purpose and Need***

- Potential sources of non-native aquatic species are monitored and prioritized according to introduction risk. Control actions are implemented when necessary to prevent or minimize introduction and establishment of new non-native species
- Fish assemblages in tributaries, where existing natural physical habitat and flow and temperature regimes support native fish reproduction, rearing, and recruitment (i.e., resident populations are supported), are dominated by native species and populations are self-sustaining

GCNP Fisheries Desired Conditions ***Purpose and Need***

- The Little Colorado River humpback chub aggregation[9] is stable, USFWS Recovery Goals[10] (see Appendix B) and demographic factors are met or exceeded, and recovery factor criteria for HBC in the Lower Basin Recovery Unit (see Glossary) are met consistent with USFWS Recovery Plans
- Humpback chub aggregations persist in one or more tributaries where each population is stable (i.e., recruitment rate greater than or equal to adult mortality rate) and at carrying capacity, with genetic integrity maintained. Note: Genetic integrity in small tributary populations may be maintained through periodic supplemental stocking if needed
- Population redundancy for HBC outside the Little Colorado River (LCR) exists in one or more tributary inflow or other mainstem aggregations, where reproduction and recruitment are occurring such that the combined tributary, tributary inflow[11], or mainstem populations, are equal to or greater than minimum viable population size. Note: Minimum viable population size to be determined by USFWS
- Management of GCNP fish communities supports razorback sucker conservation efforts in Lake Mead and contributes toward species recovery
- Recruitment of razorback sucker in upper Lake Mead and Lower Colorado River FMZ is documented and supports maintenance and expansion of Lake Mead's razorback population
- Threats of predation or competition to native species from existing non-native species are managed to promote native species spawning, rearing, survival, and dispersal
- In the mainstem Colorado River, existing (non-listed) populations of native fish including speckled dace and flannelmouth and bluehead suckers are stable

[9] A consistent and disjunct group of fish with no significant exchange of individuals with other aggregations, as indicated by recaptured of tagged juveniles and adults and movement of radio-tagged adults (Valdez and Ryel 1995)

[10] What do we mean by recovery? Recovery is the process that stops the decline of an endangered or threatened species by removing or reducing threats. Recovery ensures long-term survival of a species in the wild. At that point, the species is recovered, and Endangered Species Act protection is no longer necessary. However, all native species remain protected within national parks. See Appendix B for more information on Recovery

[11] The area where a tributary stream or river flows into a larger body of water

- Extirpated fish species have been reintroduced, where appropriate, following reintroduction feasibility studies, and populations are self-sustaining

GCNRA Fisheries Desired Conditions Glen Canyon Reach ***Purpose and Need***

- A highly valued recreational rainbow trout fishery is maintained with minimal emigration downstream to GCNP such that:

    - Opportunities are present for anglers to have a memorable fishing experience in a unique setting
    - Glen Canyon Reach habitat supports a rainbow trout population with a size structure indicative of a stable population with minimal emigration downstream into Marble and Grand Canyons
    - Native fish communities are maintained in the Paria River, and to the extent practicable, given dam operations, the Colorado River

RELATIONSHIP TO OTHER PLANS AND POLICIES

Development of proposed actions analyzed in the CFMP EA incorporate goals and objectives set forth in the following policies, mandates, plans, and programs of the NPS, AZGF, USBR, and USFWS.

NPS Mission

The "Organic Act" of August 25, 1916, states, "the Service thus established shall promote and regulate the use of Federal areas known as national parks, monuments and reservations…by such means and measures as conform to the fundamental purpose of the said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

NPS Laws, Mandates and Policies Other Plans and Documents

The CFMP is consistent with NPS 2006 Management Policies (Section 4.4, NPS 2006a) that require national parks to maintain native plants and animals as parts of self-sustaining, natural ecosystems, and to remove established populations of non-native species, recognizing that this should be done "to the extent possible." NPS policies state "exotic species will not be allowed to displace native species if displacement can be prevented." and "new exotic species will not be introduced into parks." Control actions are called for if species interfere with perpetuation of native species and if control is prudent and feasible. Stocking of non-native fish species may be allowed in substantially altered habitats for recreational purposes when the non-native species does not unacceptably harm natural resources and native species. NPS Wilderness management policies apply to GCNP's 1.1 million acres of Recommended and Potential Wilderness; management decisions will be consistent with Minimum Requirement Analysis (MRA).

Neither GCNP nor GCNRA have exclusive federal jurisdiction, and thus state law applies to fish management within their boundaries, but only to the extent 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 AZGFD before taking certain administrative actions to manage fish within the park units.

Glen Canyon National Recreation Area was established in 1972 by act of Congress (PL 92-593) to "provide for the public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto in states of Arizona and Utah and to preserve the scenic, scientific, and historic features contributing to the public enjoyment of the area" (16 USC 460dd).

The act states that "the Secretary shall administer, protect, and develop the recreation area in accordance with the provisions of the act of August 25, 1916 (NPS Organic Act), as amended and supplemented, and with any other statutory authority available to him for the conservation and management of natural resources" (16 USC 460dd-3).

The act further states that "the Secretary shall permit hunting, fishing, and trapping on the lands and waters under his jurisdiction within the boundaries of the recreation area in accordance with applicable laws of the Unites States and the States of Utah and Arizona, except that the Secretary may designate zones where, and establish periods when, no hunting, fishing, or trapping shall be permitted for reasons of public safety, administration, or public use and enjoyment. Except in emergencies, any regulation of the Secretary pursuant to this section shall be put into effect only after consultation with the appropriate State fish and game department" (16 USC 460dd-4).

Plans and Programs **Other Plans and Documents**

A number of plans and programs relate to proposed actions according to agency or park unit.

Grand Canyon National Park **Other Plans and Documents**

- **General Management Plan** Proposed actions in this CFMP EA are consistent with management objectives set forth in the GMP (NPS 1995) to
  - Preserve and protect genetic integrity and species composition consistent with natural ecosystem processes
  - To the maximum extent possible, restore altered ecosystems to their natural conditions. In managing naturalized ecosystems, ensure preservation of native components through active management of nonnative components and processes
  - Manage ecosystems to preserve critical processes and linkages that ensure preservation of rare, endemic, and specially protected (threatened and endangered) plant and animal species
  - Provide opportunities for scientific study and research focused on Grand Canyon consistent with resource protection and park purposes
  - Inventory, monitor, and maintain data on park natural and cultural resources and values, and use this information in the most effective ways possible to facilitate park management decisions to better preserve the park
- **Colorado River Management Plan (CRMP)** While the CRMP (NPS 2006b) primarily addresses river corridor recreational uses, it also establishes an approval process, responsibilities, and administrative use procedures for research and monitoring including the GCD Adaptive Management Program (GCDAMP) and work conducted by the U.S. Geological Service's (USGS) Grand Canyon Monitoring and Research Center (GCMRC). Actions proposed in the CFMP EA incorporated CRMP procedures
- **Backcountry Management Plan (BMP)** The CFMP EA is consistent with the GCNP Backcountry Management Plan (NPS 1988). Fish management activities proposed in backcountry and Wilderness would occur at existing use levels. In addition, Leave No Trace principles and Minimum Requirement Analysis would be employed by fisheries crews

- **Bright Angel Creek Trout Reduction Project EA** The project (NPS 2006c) collected data consistent with and incorporated into proposed CFMP actions. The CFMP EA includes a more comprehensive approach for minimizing non-native trout in Bright Angel Creek and Bright Angel Creek Inflow by expanding on past work. The CFMP will replace the 2006 Trout Reduction EA

Glen Canyon National Recreation Area **Other Plans and Documents**

- **Proposed General Management Plan, Wilderness Recommendation, Road Study Alternatives, and Final Environmental Statement** Proposed CFMP EA actions are consistent with this GCNRA plan (NPS 1979) because the EA "provides for public outdoor recreation use and enjoyment… (and) preserves scenic, scientific, and historic features contributing to public enjoyment of the area."
- **Fish Management Plan** The plan (UDNR 1996) identified concerns and issues related to fish management and established mechanisms for interagency coordination to "Protect the integrity of aquatic habitats and water quality, protect and restore native fish species in suitable habitats in GCNRA, and promote and provide quality recreational fishing opportunities in GCNRA." Actions proposed in the CFMP EA are consistent with the GCNRA plan
- **Upriver Recreation Plan and Environmental Assessment for Lees Ferry** The Upriver Recreation Plan and EA for Lees Ferry (NPS 1984) analyzes recreational impacts on the Colorado River upstream from Lees Ferry in the Glen Canyon Reach . CFMP EA proposed actions are consistent with the analysis and requirements associated with camping areas identified in the GCNRA plan
- **Lees Ferry Development Concept Plan (DCP)** The DCP (NPS 1986) addresses changing conditions, use patterns, and demands in the Lees Ferry area, and provides guidance regarding acceptable development and uses in GCNRA. Consistent with this plan, all river travel proposed in the CFMP EA for anglers, researchers, and others would use Lees Ferry to access the river

Arizona Game and Fish Department **Other Plans and Documents**

- **Arizona Statewide Conservation Agreement for Roundtail Chub (*Gila robusta*), Headwater Chub (*Gila nigra*), Flannelmouth Sucker (*Catostomus latipinnis*), Little Colorado River Sucker (*Catostomus spp.*), Bluehead Sucker (*Catostomus discobolus*), and the Zuni Bluehead Sucker (*Catostomus discobolus yarrowki)*** This agreement (AZGFD 2006) outlined a strategy to minimize threats to the conservation of six species. CFMP EA proposed actions are consistent with this agreement and incorporate steps that would minimize threats to bluehead and flannelmouth suckers

Bureau of Reclamation **Other Plans and Documents**

- **Final Environmental Impact Statement and Record of Decision on the Operation of GCD** (1995/1996) This EIS analyzes impacts of GLC operations from 1963 to 1990 (baseline conditions) and Alternative operations on downstream environmental and cultural resources of Glen and Grand Canyons. The document and decision attempted to balance benefits to all resources in identifying a Preferred Alternative that implemented a 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. The Preferred Alternative was the Modified Low Fluctuating Flow Alternative and included establishment of an Adaptive Management Program, the Adaptive Management Work Group, and a research and science program (now under the direction of the USGS at the GCMRC)
- **Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead Final EIS** The EIS (USBR 2007) identifies

mechanisms for addressing discrete levels of shortage volumes associated with Lake Mead elevations relative to Lake Powell reservoir conditions. The EIS provides for water deliveries to balance and/or equalize the two reservoirs, in addition to mechanisms to account for conservation, augmentation, and water conservation strategies.

- **Comprehensive Plan for Management and Conservation of Humpback Chub (*Gila cypha*) in the Lower Colorado River Basin** CFMP EA proposed actions are consistent with this plan (GCDAMP 2009). The list and ranking of identified threats and conservation methods were incorporated into CFMP proposed actions
- **GCD Long-Term Experimental and Management Plan EIS (LTEMP)** The LTEMP (USBR, NPS in prep) will guide flow and non-flow options for conserving resources downstream of GLC, consistent with the Grand Canyon Protection Act. The CFMP EA addresses non-flow related fisheries management activities consistent with draft goals of this plan
- **Non-native Fish Control Downstream from GCD EA** The EA (USBR 2011) addressed the control of non-native fish in the Colorado River downstream of GCNRA to alleviate effects of competition and predation on endangered humpback chub. The CFMP EA complements actions approved in the USBR EA by taking a comprehensive approach to non-native fish control
- **Lake Mead Razorback Sucker Working Group (LMRSWG)** An interagency group currently collaborating on plans to recover razorback sucker in Lake Mead and Lower Colorado River FMZ as identified in this CFMP EA. The CFMP EA compliments the LMRSWG by expanding razorback sucker recovery in Lake Mead into the Colorado River inflow and Lower Colorado River FMZ

U.S. Fish and Wildlife Service Other Plans and Documents

- **Recent Biological Opinions** (USFWS 2008, 2011) on GCD operations or coordinated reservoir operations for Lake Mead and Lake Powell (USFWS 2007) mandated several conservation or reasonable and prudent measures to mitigate risks to humpback chub and razorback sucker in Grand Canyon. Conservation measures analyzed in the CFMP EA include: 1) humpback chub translocations to tributaries outside the Little Colorado River, and associated monitoring; 2) expanded brown trout control around Bright Angel Creek; 3) non-native fish control in tributaries and the mainstem; 4) mainstem humpback chub aggregation conservation; and 5) habitat evaluation and augmentation or management plan development for razorback sucker for Lower Colorado River FMZ
- **Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Bureau of Reclamation** Guidelines (USFWS 2007) include a conservation measure for razorback sucker (*Xyrauchen texanus*) that directs agencies to "…undertake an effort to examine the potential of habitat in the Lower Grand Canyon [Lower Colorado River FMZ] for the species, and institute an augmentation program in collaboration with USFWS, if appropriate."
- **Razorback Sucker (*Xyrauchen texanus*) Recovery Plan** The plan (USFWS 2002 as amended) and goals describe species threats, recovery criteria, management, research, and monitoring activities to improve status species. The CFMP EA furthers conservation of the Lower Colorado River FMZ Razorback Sucker population by identifying a management and augmentation study plan for Lower Colorado River FMZ
- **Humpback Chub Recovery Plan** The plan (USFWS 2002 as amended) describes threats, recovery criteria, management, research, and monitoring activities to improve species status. The CFMP EA moves toward conservation of the GCNP humpback chub population by identifying

non-native fish control programs (i.e., brown trout) for minimizing predation on and translocating humpback chub among other actions

SCOPING

Scoping identifies possible impacts from a proposed action to resources, and explores Alternatives to achieve objectives while minimizing adverse impacts. GCNP and GCNRA conducted internal scoping with NPS staff. External scoping was conducted with the public, interested/affected groups, and twelve Traditionally Associated American Indian Tribes (see Chapter 4).

On June 1, 2012, GCNP issued a press release to solicit comments for the Comprehensive Fisheries Management Plan for Grand Canyon National Park and Glen Canyon National Recreation Area. The press release and a project scoping document were posted to the Planning, Environment, and Public Comment (PEPC) site with a review and public comment period of June 1 to June 30, 2012. Additionally, project scoping information was e-mailed to more than 1,000 individuals, and interested or affected groups. The majority of this outreach effort consisted of federal and state agencies, Native American tribes, environmental groups, businesses, local government agencies, tourism offices, and news organizations in Arizona, Utah, and Nevada.

During the public scoping period for this project, 57 letters were posted to the PEPC website from unaffiliated individuals, state and federal agencies, fly fishing clubs, angler advocacy groups, fishing guides, and others who work in the recreational fishing industry.

The most common concerns and comments were

- a majority of responses supported Glen Canyon recreational fishing
- state and federal water and power agencies suggested the CFMP be integrated with the LTEMP EIS or delayed until LTEMP was completed
- support for local economic benefits of recreational fishing at and around Lees Ferry
- general support for a Comprehensive Fisheries Management Plan
- support for simultaneous efforts to maintain and restore both the recreational fishery and native fish populations

Additional meetings were hosted to consult with Native American tribes, USFWS, and AZGFD. See Chapter 4, Consultation and Coordination for more information on external scoping and Native American consultation.

ISSUES AND IMPACT TOPICS

Impact topics for this project were identified through examination of federal laws, regulations, executive orders, and NPS 2006 Management Policies (NPS 2006a), and as a result of internal and public scoping.

Federal regulations (40 CFR 1500 et seq.) and Director's Order 12: Planning, Environmental Impact Analysis and Decision Making, require certain topics be addressed as part of a NEPA analysis. During internal scoping, the park's interdisciplinary team conducted a preliminary analysis of resources to determine context, duration, and intensity of effects proposed actions may have on resources. If the magnitude of effects was determined negligible or minor, further impact analysis is unnecessary, and the resource was dismissed as an impact topic. If a resource is found in the analysis area or the issue is applicable to the proposal, then a limited analysis of direct, indirect, and Cumulative Effects was

conducted. This allowed NPS and the public to concentrate on issues relevant to the action in question, rather than amassing detail, in accordance with CEQ regulations at 1500.1(b). If however, during internal scoping and further investigation, resource effects still remain unknown, or are expected to be at least moderate intensity, then the resource is carried forward as an impact topic for analysis.

Impact Topics Retained for Analysis

Resource topics developed from internal and public scoping on the EA (see Chapter 4) and retained for further analysis in this EA include

- Fisheries
- Ethnographic Resources
- Visitor Use and Experience
- Wilderness Character
- Non-Fish Special Status Species

Impact Topics Dismissed from Further Analysis

The following topics were considered but dismissed from detailed analysis because they would not be affected by Alternatives actions or impacts would be negligible to minor. Common to each of the following resource topics, to avoid unnecessary impacts, transport of personnel and equipment would generally occur over established roads and trails, on the Colorado River using helicopters or motorized and non-motorized boats (consistent with NPS Minimum Requirement Analysis). Personnel would generally overnight in established campsites. If non-established campsites are used, all personnel would be trained in and required to adhere to minimal impact techniques. These criteria are also identified in Chapter 2.

Socioeconomics **Impact Topics Dismissed**

Although the GCNRA recreational rainbow trout fishery contributes to the larger recreation- and tourism-driven economy of northern Coconino County, Alternatives considered in this EA would not be expected to result in measurable differences to the local or regional economy attributed to recreational fishing. Maintenance of a recreational rainbow trout fishery at GCNRA is Common to All Alternatives. Increased management of the Glen Canyon Reach fishery may result in minor beneficial effects associated with potential for increased size and weight of individual rainbow trout through stocking of sterile rainbow trout in case rainbow trout density declines.

Potential economic effects of controlling non-native fish in Bright Angel Creek in GCNP were discussed and dismissed from detailed analysis in the Bright Angel Creek Trout Reduction Project EA (NPS 2006c) due to limited potential effects. Some hikers and rafters do engage in fishing; however, only a very small percentage of visitors who hike to or raft the Colorado River in GCNP do so principally to fish (NPS 2006c). Proposed actions would not result in a measureable impact to either visitation or visitor spending in GCNP or GCNRA, or for concessioners or gateway communities. Therefore, this topic is dismissed from further analysis.

Soundscapes **Impact Topics Dismissed**

For the CFMP EA, effects of manmade noise are discussed in the following impact topics: Non-fish Special Status Species, Wilderness Character, and Visitor Experience. Park natural soundscape resources encompass all natural sounds that occur including the physical capacity for transmitting those natural sounds and interrelationships among park natural sounds from different sources of different frequencies and volumes. Natural sounds occur in and beyond the range of sounds humans can perceive, and can be transmitted through air, water, or solid materials. The NPS will preserve, to the greatest extent possible,

natural soundscapes (Section 4.9, NPS 2006a).

Intrusive sounds that disturb soundscape, wildlife, Wilderness Character, and/or the opportunity for visitors to enjoy natural sounds can adversely affect park resources and visitors, and in some cases may even impede the NPS ability to accomplish its mission. However, given the small number of days noise-creating activities would occur (e.g., 20-40 nights electro-fishing) and limited geographic area where human-caused noise would be evident, natural sounds would predominate throughout the project area for the majority of the year (see Chapter 3, Visitor Experience, Wilderness Character, and Wildlife for further discussion).

Based on the above analysis, impacts to Soundscape are expected to be negligible to no more than minor adverse on the small number of days when noise-producing fish management activities take place. Therefore, this topic is dismissed from further analysis. Noise impacts on Visitor Experience, Wilderness Character, and Non-Fish Special Status Species are evaluated along with other non-noise impacts under those impact topics.

Geology and Soils **Impact Topics Dismissed**

Geologic resources in the two park units are not likely to be impacted by actions proposed in this CFMP EA. Impacts to soils would result from movement of personnel along stream and riverbanks when performing monitoring, fish relocation, electro-fishing, and other fisheries management operations. Travel in uplands would be mostly on trails, so no detectable impacts are expected in uplands. Biologists would be instructed to avoid areas sensitive to disturbance such as wetland and biological soil crusts to the greatest extent possible while conducting their work. Proposed actions would not have measurable effects beyond current levels of streamside use by visitors and staff. Therefore, actions taken to manage fisheries would result in localized short-term negligible adverse effects to geology and soils. Therefore, this topic is dismissed from further analysis.

Floodplains and Wetlands **Impact Topics Dismissed**

The Clean Water Act of 1972 requires consideration of proposed action impacts on chemical, physical, and biological integrity of jurisdictional waters of the U.S. Executive Order 11990, Protection of Wetlands, requires federal agencies to avoid actions, where possible, that would adversely impact wetlands. Further, §404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to prohibit or regulate through a permitting process, discharge of dredged or fill material or excavation in waters of the U.S. NPS wetlands policies, as stated in NPS 2006 Management Policies (Section 4.6.5, NPS 2006a) and Director's Order 77-1,Wetlands Protection, strive to prevent loss or degradation of wetlands and to preserve and enhance natural and beneficial values of wetlands. Proposed actions with potential to adversely impact wetlands must be addressed in a statement of findings for wetlands. Executive Order 11988, Floodplain Management, requires all federal agencies to avoid construction in the 100-year floodplain unless no practicable Alternative exists. Under the NPS 2006 Management Policies (NPS 2006a) and Director's Order 77-2, Floodplain Management, the agency will strive to preserve floodplain values and minimize hazardous floodplain conditions.

Proposed fisheries management actions do not involve fill material deposition, streamflow or channel morphology alterations, or use of contaminants in water resources, floodplains, or wetlands. Biologists wading in tributaries during weir operations and electro-fishing may stir up bottom sediments resulting in minor short-term localized increases in turbidity. However, proposed actions would not have measurable effects beyond current levels of use by visitors and staff. Therefore, this topic is dismissed from further analysis.

Water Quality and Quantity **Impact Topics Dismissed**

The Clean Water Act of 1972 requires consideration of impacts on United States jurisdictional waters and potential for polluting surface waters. Water quality parameters include temperature, pH, turbidity, total dissolved solids, numerous chemical elements and compounds, and pathogens (disease-causing microbes). Designated uses for the Colorado River below GCD include agriculture, aquatic wildlife (cold-water fishery), domestic water, fish consumption, and swimming. For further information, the draft 2010 Status of Water Quality in Arizona 305(b) Assessment and 303(d) Listing Report[12] may be downloaded from the Arizona Department of Environmental Quality (ADEQ) website http://www.azdeq.gov/environ/water/assessment/assess.html.

NPS 2006 Management Policies require protection of water quality consistent with the Clean Water Act, and state NPS will perpetuate surface and groundwaters as integral components of park aquatic and terrestrial ecosystems. Proposed actions would not discharge chemical elements, compounds, or pathogens, nor would they introduce new contaminants. Proposed actions would not have measurable effects beyond current levels of use by visitors and staff. Short-term effects to water quality would be negligible; therefore, this topic is dismissed from further analysis.

General Wildlife **Impact Topics Dismissed**

NPS 2006 Management Policies (Section4.4, NPS 2006a), GCNRA's 1979 General Management Plan, GCNP's 1995 General Management Plan, and other NPS policies provide for protection of naturally occurring biotic communities in GCNP and GCNRA. Approximately 355 bird, 89 mammal, 47 reptile, 9 amphibian, and thousands of aquatic and terrestrial invertebrate species can be found in GCNP and GCNRA's Glen Canyon Reach .

Activities associated with the proposed action would not exceed current backcountry use levels. Travel to work locations would be by boat or backcountry hiking. Biologists entering and leaving waterways to implement proposed actions would choose routes that avoid streamside vegetation to minimize trampling of wildlife habitats and disturbance to wildlife. This project proposes occasional electro-shocking at night which could impact bats active at night. This activity would be infrequent and localized, and measurable effects to bat species are not expected. The level of noise and human activity associated with proposed actions would be low, and no terrestrial wildlife habitat would be altered. It is unlikely general wildlife would be disturbed at more than a negligible level as a result of proposed actions. Therefore, this topic is dismissed from further analysis.

Vegetation Including Exotic Plant Species **Impact Topics Dismissed**

GCNP and the Glen Canyon Reach are home to a great diversity of vascular and non-vascular plants, fungi, and lichens in at least 129 vegetation communities. Over 850 species have been reported from GCNRA, and over 1,750 vascular plant species from GCNP. Riparian and desert scrub plant communities occur along the Colorado River and its perennial tributaries. Riparian communities are dominated by species such as coyote and seep willows, arrowweed, western honey mesquite, catclaw acacia, and exotic tamarisk with many other species present. The desert scrub community is dominated by species such as creosote, white bursage, brittle brush, ocotillo, four-wing saltbush, big sagebrush, ephedra, dropseed, brome grasses, and many other species.

Most GCNRA monitoring and fisheries management activities would occur from boats launched from the Lees Ferry established boat launch. In GCNP, CFMP EA Alternatives include fisheries management activities such as monitoring, electro-fishing, weir operation, and fish translocation. Staff transport to and

[12] ADEQ submitted the 2010 draft to the Environmental Protection Agency (EPA) in October 2012

from fisheries management sites would occur using rafts, helicopters, and hiking established trails. Vegetation impacts would most likely be where fisheries management crews cross riparian areas to access streams. Riparian vegetation communities evolved under a regime of periodic flood, drought, fire, wildlife, and other disturbance. However, repeated human disturbance can result in vegetation trampling, soil compaction, social trail creation, and bare areas. To ensure potential vegetation impacts are minimized, fisheries biologists would consult with vegetation specialists on whether special status plants or sensitive habitats exist in project areas. Field biologists would be instructed in identification and avoidance measures for possible special status and rare plants. Field personnel would choose routes that avoid streamside vegetation to minimize trampling and avoid repeated use of the same path to avoid social trail creation. Should a social trail be created, resource specialists would be notified, and rehabilitation would occur.

Approximately 11% of flora in GCNP and the Glen Canyon Reach is exotic. Executive Order 13112, Invasive Species, directs federal agencies to use relevant programs and authorities to prevent introduction of exotic plant and aquatic invasive species; provide for their control; and minimize economic, ecological, and human health impacts invasive species cause. All equipment (including personal gear like waders) associated with proposed actions would be cleaned prior to and after use to ensure no invasive plant or aquatic invasive species are introduced into the project area. To avoid transporting exotic plant species between sites, fisheries biologists use gear and equipment specifically designated for use in each location (i.e., Bright Angel Creek equipment would not be used in Shinumo Creek). Fisheries biologists would be instructed on how to identify exotic plant species and avoid transporting them from one location to another. With this mitigation measure in place, proposed actions would not aid in invasive exotic plant species spread. Therefore, exotic vegetation is dismissed from further analysis. Due to potential magnitude of impacts to native and recreational fisheries, aquatic invasive species are discussed in this EA.

Widespread vegetation disturbance is not expected through CFMP implementation. Actions to manage fisheries would result in short-term negligible adverse effects to vegetation. Proposed actions would not contribute detectably to current levels of vegetation trampling. Therefore, this topic is dismissed from further analysis.

Air Quality **Impact Topics Dismissed**

Section 118 of the Clean Air Act requires park units to meet federal, state, and local air pollution standards. GCNP is designated a Class I air quality area under the Clean Air Act, and GCNRA is designated a Class II area under the Act. GCNP receives stringent protection against increases in air pollution and further degradation of air quality-related values. A Class II designation indicates the maximum allowable increase in concentrations of pollutants over baseline concentrations of sulfur dioxide and particulate matter as specified in §163 of the Clean Air Act.
Proposed actions would not result in detectable levels of airborne dust. Much personnel and equipment transportation would occur by foot or using motorized and non-motorized rafts. Automobile, helicopter, and motorboat use could result in temporary increases in vehicle exhaust, and helicopters would stir up some dust when landing at project work sites. However, helicopters and motorboats would be used infrequently.

Overall, actions taken to manage fisheries would result in short-term negligible localized adverse effects to air quality. Proposed actions would not contribute detectably to changes in air quality. The scope of this project does not require consultation with the State of Arizona regarding air quality. The Class I air quality designation for GCNP, and Class II designation for GCNRA, would not be affected by the proposal. Therefore, this topic is dismissed from further analysis.

Prime and Unique Agricultural Lands **Impact Topics Dismissed**

The Farmland Protection Act of 1981, as amended, requires Federal agencies to consider adverse effects to prime and unique farmlands resulting in conversion of these lands to non-agricultural uses. There are no agricultural lands in GCNP or GCNRA, and proposed Alternatives would not have direct or indirect effects on downstream agricultural lands. Therefore, this topic is dismissed from further analysis.

Climate Change and Sustainability **Impact Topics Dismissed**

A growing body of scientific evidence and real-world observations support the notion that global climate change is occurring. The future effects of climate change may result in changes in weather patterns across the planet and may include changes in the frequency of drought and annual precipitation cycles, fire regime shifts, changes in the distribution of native and non-native species, as well as loss of habitat. While the extent of climate change-related impacts over the long-term are uncertain, climate change may impair the ability of the NPS to conserve and protect resources within national parks for future generations. Anthropogenic climate change is driven by greenhouse gas emissions on a global geographic scale, far beyond the scope of this CFMP. Actions considered in this EA would result in minimal change in greenhouse gas emissions under any alternative, and thus, this topic was dismissed from further analysis in the EA.

Cultural Resources **Impact Topics Dismissed**

Analysis of impacts to cultural resources is required by the National Historic Preservation Act of 1966 (as amended); Archeological Resources Protection Act of 1979; Native American Graves Protection and Repatriation Act of 1990; NPS 2006 Management Policies (NPS 2006a); and other federal statutes, policies, and guidelines. In addition, NEPA regulations at 40 CFR 1508.27 require the intensity of potential impacts be evaluated in terms of potential adverse effects on cultural resources.

- **Archaeological Resources**

Most of the project work under each of the alternatives would occur below the high water mark of the Colorado River and its tributaries. Fisheries work occurring in the Colorado River would primarily be conducted from boats. Crews would work along the river bank and banks of tributaries and these areas would be accessed by established trails. Work is designed to avoid known archaeological resources. No known archaeological resources in GCNP would be impacted by actions proposed for this project.

There is one archaeological site present within the project's area of potential effect in GCNRA; it is a partially submerged historic archaeological site. This site is a contributing feature to the National Register listed Lees Ferry and Lonely Dell Ranch Historic District. The proposed project action occurring in the Lees Ferry area is the stocking of sterile trout and it would not occur in the vicinity of the site. This would have no impact on the characteristics of the archaeological site that qualify it as a contributing feature to the historic district. There would be no noticeable or barely detectable impacts; the impacts would be negligible. The finding of effect for the purpose of Section 106 would be no historic properties affected. Therefore, this topic was dismissed from further analysis.

- **Historic Structures**

In GCNP and GCNRA there are no historic structures located in the proposed project's area of potential effect. No historic structures would be impacted by actions proposed under this project. Under Section 106 of the National Historic Preservation Act, the finding of effect would be no historic properties would be affected. Therefore, this topic was dismissed from further analysis.

- **Cultural Landscapes**

Two cultural landscapes are located within the proposed project area, one is in GCNP and one is in GCNRA.

In GCNP The Cross-Canyon Corridor Historic District (district), consisting of the Bright Angel Trail, Colorado River Trail, North Kaibab Trail, and South Kaibab Trail is located within the proposed project area in GCNP. Fisheries work is proposed in and along the banks of Bright Angel Creek, under both action alternatives, which is located within the district. Crews would work along the creek banks and would access different sites by established trails. A fish weir would be placed in Bright Angel Creek below the creek banks. The weir would be a small scale, (12 foot x 12 foot metal fence-like structure) temporary feature spanning the width of the creek during part of the year under Alternatives 2 and 3. The weir would be visible from a few areas within the historic district, the lower Bright Angel Campground trail and rockhouse bridge near Phantom Delta area and a small section of the North Kaibab Trail. Other project work would occur primarily in the creek or be conducted below the creek's high water mark.

The proposed actions would be localized, visible from only a small portion of the district, temporary, and slight, and while noticeable they would not appreciably alter resource conditions. Potential impacts to the Cross-Canyon Corridor Historic District would be local, short-term, and minor adverse.

The Lees Ferry and Lonely Dell Ranch Historic District is within the project area in GCNRA. The boundary of this National Register property encompasses the partially submerged historic archaeological site, which is a contributing feature to the Lees Ferry and Lonely Dell Ranch Historic District. There are no other historic district contributing features within the project area. The proposed action occurring in the Lees Ferry area is the stocking of sterile trout. This action would have no impact on the characteristics of the Lees Ferry and Lonely Dell Ranch Historic District that qualify it for National Register listing and that qualify the partially submerged historic archaeological site as a contributing feature to the historic district. There would be no noticeable or barely detectable impacts; the impacts would be negligible. The finding of effect for the purpose of Section 106 would be no historic properties affected. Therefore, this topic was dismissed from further analysis.

Indian Trust Resources **Impact Topics Dismissed**

Under Department of the Interior (DOI) Secretarial Order 3175 and DOI Environmental Compliance Memorandum 95-2, agencies of the department are required to consider effects of their actions on Indian trust assets, defined as legal interests in property held in trust by the federal government for the benefit of Indian tribes or individuals. Examples of such assets include lands, mineral rights, hunting and fishing rights, and water rights. No Indian trust resources exist in the project area, so none would be affected by proposed actions. Therefore, this topic is dismissed from further analysis.

Environmental Justice **Impact Topics Dismissed**

Executive Order 12898 General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of programs and policies on minorities and low-income populations and communities. Executive Order 13045 requires Federal actions and policies identify and address disproportionally adverse risks to health and safety of children. None of the Alternatives in this CFMP EA would have disproportionate health or environmental effects on minorities or low income populations or communities or to the health and safety of children. Therefore, this topic is dismissed from further analysis.

Land Use **Impact Topics Dismissed**

Land use and development of visitor and park facilities in GCNP and GCNRA is managed under the NPS Organic Act, NPS 2006 Management Policies (NPS 2006a) and associated Directors Orders, GCNP and GCNRA enabling legislation, the Wilderness Act, and others. None of the proposed Alternatives would fundamentally affect land use in GCNP and GCNRA. Therefore, this topic is dismissed from further analysis.

Park Operations **Impact Topics Dismissed**

Fisheries biologists would conduct proposed actions. GCNP and GCNRA rangers would help educate visitors about the purpose of the action and would provide routine law enforcement and other support. Staff from other divisions would also provide routine support. These support services are expected to have negligible effects on park operations at both GCNP and GCNRA. Therefore, this topic is dismissed from further analysis.

Public Health and Safety **Impact Topics Dismissed**

NEPA regulations at 40 CFR 1508.27 require the intensity of potential impacts be evaluated in terms of potential adverse effects on public health and safety. Human health and safety issues in GCNRA and GCNP are addressed under other park unit plans such as the Colorado River Plan, which addresses river travel, and GCNP's 1995 and GCNRA's 1979 General Management Plans. Proposed actions include electro-fishing, which does have a slight potential to harm field crews. Other hazards faced by field crews include rough terrain, river travel, work in hot weather and moving waters, biting insects, and poisonous snakes.

Standard Operating Procedures and Job Hazard Analyses guide daily operations to provide the safest possible work environment for employees and volunteers. Annually reviewed job hazard analyzes are developed for many techniques such as electro-fishing to define required techniques and tools, identify hazards, and mitigate potential for injury, and are required reading for all staff and volunteers. Workers and volunteers also hold meetings at the beginning of each field project to review safety plans and procedures. Managers for each park unit prepare comprehensive safety plans reviewed by park unit safety officers. Proposed actions are not expected to pose hazards to park visitors. Therefore, this topic is dismissed from further analysis.

CHAPTER 2 ALTERNATIVES

INTRODUCTION

Formulation of CFMP Action Alternatives began in 2010 when GCNP hosted two workshops with stakeholders, agencies, and tribes (see Chapter 4) to develop broad goals and GCNP site-specific objectives, and brainstorm and rank management actions to meet those goals and objectives. In 2012, a third workshop was held by GCNRA to discuss goals for Glen Canyon fisheries and obtain feedback from stakeholders related to rainbow trout fishery management. Following scoping, two additional meetings, interdisciplinary team discussions, and several informal discussions were held among USBR, AZGFD, USGS-GCMRC, USFWS, and NPS resource specialists to develop Alternatives (see Chapter 4).

This chapter describes a No Action Alternative and two Action Alternatives for managing fisheries in the Glen Canyon Reach and all GCNP waters that could potentially meet Chapter 1's project objectives. Table 2.7 compares elements across Alternatives.

ELEMENTS COMMON TO ALL ALTERNATIVES

Best Management Practices **Elements Common to All Alternatives**

The following best management practices would be followed for all Alternatives, as appropriate.

Electro-fishing **Elements Common to All Alternatives**

- Electro-fishing gear will be set to avoid injury to native fish
- In tributaries where humpback chub have been released, electro-fishing equipment will be minimized in large-volume, deep pools where gear is less effective in capturing fish, and where humpback chub tend to congregate
- Block nets will be used during multiple-pass depletion electro-fishing, where native fish are present, to minimize applying electrical current to individual fish multiple times. Fish will be released downstream of block nets and outside the sampling area between passes
- The least-intensive electro-fishing settings that effectively sample fish will be used in all cases. For example, during tributary electro-fishing in Grand Canyon, a pulsed-DC at a frequency of 30-40 Hz (300-350 volts) has proven sufficient
- Fish captured using electro-fishing will be monitored in buckets, and gear settings would be adjusted if sufficient recovery is not observed
- Crew members will be sufficiently trained in electro-fishing techniques
- Netters and electrodes will be positioned so fish can be removed from electrical fields as quickly as possible

General Fish Handling **Elements Common to All Alternatives**

- Trammel net use will be minimized when possible, and will not be used if water temperatures exceed 16°C. Trammel nets would be checked every two hours or less
- Feasibility of experimental mobile PIT-tag antenna probe use, where no handling of fish is necessary, will be determined and considered for future sampling in lieu of handling PIT-tagged humpback chub
- During sampling efforts, all native fish will be processed first, and handling time for captured humpback chub will be minimized whenever possible
- If incidental mortality occurs, humpback chub otoliths will be extracted and preserved (if feasible) and preserved in 100% ethanol; otherwise, the entire fish will be preserved and deposited into GCNP's study collection

- GCMRC's General Guidelines for Handling Fish to minimize fish injury would be followed during all field projects (Persons et al 2013)
- No bait, or an artificial or natural substance that attracts fish by scent and/or flavor (i.e., live or dead minnows/small fish, fish eggs, roe, or human food), would be used by anglers participating in non-native fish control efforts. Barbless hooks would be used for trout removal activities
- During Lower Grand Canyon larval and small-bodied fish surveys, captured humpback chub large enough to be identified in the field (greater than about 20 mm) will be released alive to the extent possible

Aquatic Nuisance Species (ANS) **Elements Common to All Alternatives**

- A Hazard Analysis and Critical Control Point plan will be developed for projects conducted under the selected Alternative
- Standard quarantine/hatchery pathogen and disease testing and treatment procedures will be followed to prevent ANS transfer of from one water to another during humpback chub (or other native fish) translocations
- To prevent inadvertent movement of disease or parasitic organisms among fish sites, research and management activities would conform to the Declining Amphibians Population Task Force Fieldwork Code of Practice[13], with exception that 10% bleach solution or 1% quaternary ammonia should be used to clean equipment rather than 70% ethanol. Abiding by this Code will effectively limit potential spread of pathogens via fish sampling equipment

Interagency Coordination **Elements Common to All Alternatives**

- All sampling activities would be coordinated with AZGFD (per 43 CFR part 24) and the USFWS Arizona Fish and Wildlife Conservation Office, USGS-GCMRC, as well as other agencies performing fish monitoring in the project area
- Annual reports documenting NPS CFMP implementation and monitoring will be provided to USFWS, AZGFD, USBR, USGS and other interested parties
- Monthly, or at least bimonthly, conference calls (or written status updates in lieu of a call) will continue to be held by the NPS Fisheries Program to update interested parties on ongoing or new NPS fisheries management activities

Elements Common To Action Alternatives

Adaptive Management **Elements Common to Action Alternatives**

Implementation of CFMP Action Alternatives relies on adaptive management to achieve goals and objectives. Adaptive management is based on clearly identified, measurable objectives and monitoring to determine if proposed actions are achieving the desired result, and implementing changes if they are not (Walters and Holling 1990) (Williams, Szaro, and Shapiro 2009). Critical to successful adaptive management is a rigorous monitoring program. Adaptive management advantages include: it accounts for uncertainty and allows for applied learning through development of a suite of predicated outcomes (i.e., alternate hypotheses), clear performance metrics or indicators, and well-informed fisheries and aquatic habitat monitoring programs prior to action initiation. Monitoring success of initial actions can be adjusted based on defined triggers to meet goals and objectives (see Figure 2.1).

CFMP Adaptive Management Strategies **Elements Common to Action Alternatives**

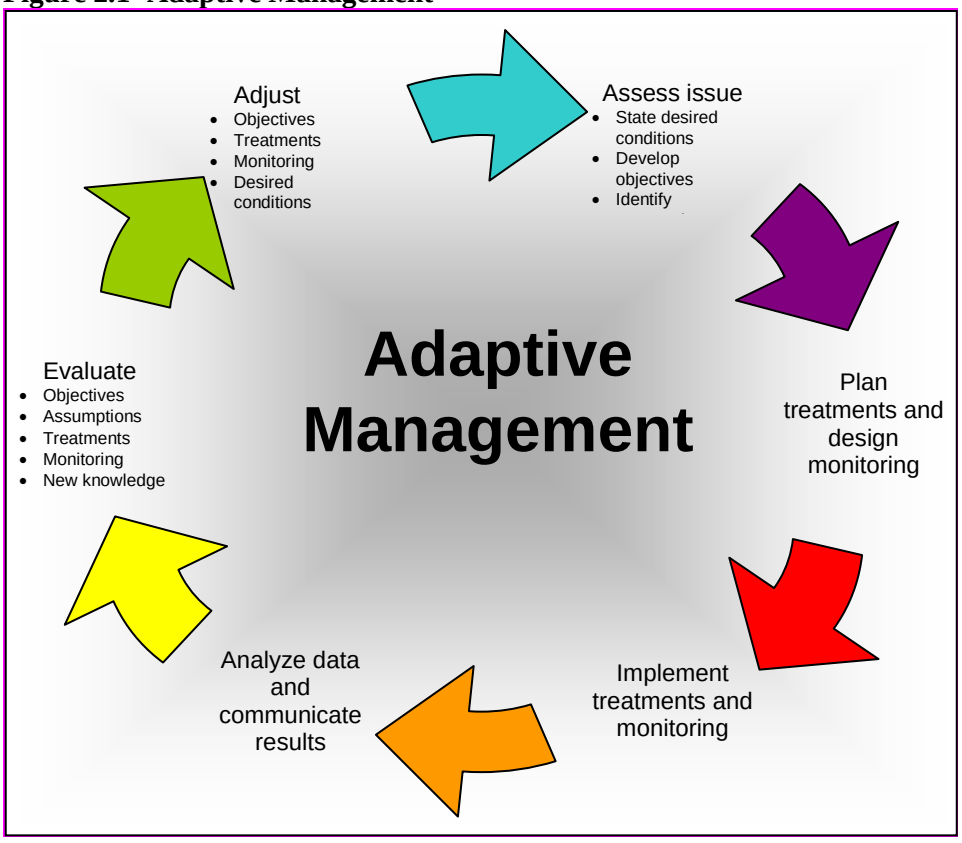
Objectives for fisheries in the project area, as described in Chapter 1, are defined by Fisheries Management Zones including Colorado River mainstem areas, tributary, and tributary inflow areas.

[13] www.nrri.umn.edu/NPSProtocol/pdfs/Amphibians/Appendix%20B.pdf

Managers would strive to meet objectives for each FMZ using management actions described in the selected Alternative . The response of fish communities to each proposed action is uncertain. For example, while the best available science and expert opinion (Kennedy 2013) indicates removal of predatory brown trout would benefit native fish species, the effort needed to effectively control and maintain brown trout at low abundances, and how native fish respond to, or are affected by these activities, is uncertain. These types of uncertainties would be addressed through monitoring and adaptive management when defined triggers are met. Key questions and uncertainties addressed through management and monitoring in this EA include

- Will translocated humpback chub and other native fish remain and reproduce? The long-term (ten or more years) response of humpback chub and other native fish to translocation to new streams or mainstem areas is relatively uncertain
- How will populations of native and non-native fish respond to potential physical (capture and handling stress) and biological (reduced competition and predation) affects of non-native fish control activities over the long term (five or more years)?
- Is habitat sufficient to maintain razorback sucker in Lower Grand Canyon?
- Can Glen Canyon rainbow trout growth, condition, and size be improved, and can emigration downstream be reduced through active management?

Figure 2.1 Adaptive Management



A hierarchal series of outcomes developed to address these questions for individual FMZs are listed in each Action Alternative. Different outcomes represent circumstances that would trigger adaptive management. These outcomes were developed based on results of past fisheries management actions and monitoring in GCNP or GCNRA, quantitative predictive models including the humpback chub population viability model (Pine et al in press); brown trout harvest model (unpublished NPS, GCMRC and AZGFD

2012); through review of published scientific literature (best available science); and expert opinion (Kennedy 2013).

Assumptions **Adaptive Management**

- Non-native fish abundance can be reduced short term (i.e., during the sampling event) using electro-fishing techniques in tributaries
- Actions, such as non-native fish control, implemented to recover or conserve endangered fish would benefit other native fish in GCNP
- Humpback chub translocated to other GCNP areas may prey on other native fish in receiving streams, but historically, these species evolved together in the Colorado River basin. There have been shifts from historical physical and biological conditions in the river that could affect inter-species relationships. However, monitoring has not revealed substantial adverse effects of HBC on other native species, and thus, minimal population-scale impacts to other native fish populations would be expected as a result of HBC translocation
- Currently, humpback chub primarily reproduce in the Little Colorado River and disperse downstream, but habitat is sufficient in some tributaries for all or most life stages, and downstream mainstem areas may occasionally support reproduction now or in the future (i.e., temperatures are occasionally sufficient farther downstream from GCD)
- Due to humpback chub high adult survival and longevity, annual recruitment may not be necessary to establish and maintain HBC in the Colorado River. Occasional recruitment may be sufficient to maintain populations long term
- Flannelmouth and bluehead sucker population trends can be effectively monitored through existing programs in the mainstem Colorado River
- If a severe decline in the GCNRA rainbow trout fishery occurs, the fishery could be effectively maintained by stocking of sterile triploid (non-reproducing) rainbow trout

Monitoring **Adaptive Management**

Adaptive management strategies would be based on existing collaborative fisheries monitoring programs established in the Colorado and Little Colorado Rivers through the GCMRC in support of GCDAMP. These programs are conducted in cooperation with USFWS, AZGFD, and NPS. Additional monitoring programs would be established through the CFMP with specific activities depending on the chosen Alternative ’s elements.

Evaluation of Outcomes **Adaptive Management**

Evaluation periods would be prescribed for each project where an adaptive strategy is taken. During that time, outcomes for each project or program would be assessed to determine if objectives were being met, and responses, that may include adaptation of current methods, implemented. Evaluation periods would include annual consultation among management agencies, sharing of results and future plans with stakeholders and Traditionally Associated American Indian Tribes, and outreach to the public.

ALTERNATIVES

ALTERNATIVE 1 NO ACTION, CURRENT MANAGEMENT

Under Alternative 1, No Action, current fisheries management, monitoring, and research would continue in GCNP and the Glen Canyon Reach . These actions could include mechanical trout control using electro-fishing between Paria Riffle and Badger Rapid in Marble Canyon, and similar trout control at the Little Colorado River Inflow to the Colorado River if humpback chub, temperature, and rainbow and brown trout triggers are met, based on USBR environmental compliance (USBR 2012b).

The NPS and AZGFD would continue to work to meet current management objectives through public outreach and aquatic invasive/nuisance species prevention activities, monitoring, and coordination with GCDAMP. Management under current fishing regulations for the Glen Canyon rainbow trout fishery would continue. The fishery and angler experience would continue to be subjected to effects of GCD operation, introduced diseases (e.g., whirling disease) or other non-native fish, and environmental factors.

In GCNP and GCNRA, outside areas where previously approved non-native fish control activities would continue (USBR 2012b), common carp and high-risk non-native predatory fish including brown trout, channel catfish, and yellow bullhead would be marked or tagged and released alive. Rare non-native fish such as smallmouth bass, walleye, striped bass, and green sunfish would continue to be collected and preserved for museum storage or future research if captured during monitoring activities.

Experimental trout control actions at Bright Angel Creek would not continue beyond 2013 due to expiring compliance documentation (NPS 2006c); however, monitoring of translocated humpback chub at Havasu and Shinumo Creeks may continue. Endangered species recovery actions and conservation measures such as humpback chub translocations and Bright Angel Creek brown trout control, included in the most recent USFWS Biological Opinion for Operation of GCD Including High Flow Experiments and Non-Native Fish Control (USFWS 2011), would be considered for implementation through separate planning and compliance processes. Similarly, conservation measures involving razorback sucker augmentation and management related to Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (USBR 2007) project would be addressed through separate planning and compliance.

Emergency Rapid Response to Detected Expansion or New Non-native Species Introduction **Alternative 1**

Consistent with NPS Director's Order-12, for emergencies including

- discovery of expansion in distribution or abundance of existing high-risk non-native species, particularly in sensitive areas for native fish (e.g., Havasu Creek or Little Colorado River Inflow areas) or
- new detection of a rapidly spreading aquatic invasive species or non-native fish species the Superintendent could approve a temporary, short-term, targeted removal effort to treat known occurrences of the new threat using mechanical methods including angling, electro-fishing, and passive (i.e., trap nets) or active (e.g., seining) netting. Simultaneously, additional planning and compliance would be considered if necessary.

ALTERNATIVE 2 NPS PREFERRED MODERATE INTENSITY FISHERIES MANAGEMENT

All actions described in Alternative 1 would be included in Alternative 2, in addition to action items described below.

Humpback Chub

Translocations Humpback Chub Alternative 2

Humpback chub translocations were included among conservation measures in the most recent Biological Opinion for GCD operation (USFWS 2011). This Alternative element includes collection of larval or juvenile HBC from the Little Colorado River, rearing in a hatchery facility until large enough to mark with individually identifiable tags, and release to tributaries or downstream areas of the Colorado River in GCNP.

If abundance of other native fish, such as bluehead or flannelmouth sucker, declines, suckers may be translocated, or collected as larvae from tributaries and reared in a hatchery prior to release following development of a translocation and augmentation plan. The release plan would incorporate methods described for humpback chub relocations and NPS 2006 Management Policies direction for genetics management (Section 4.4.1.2, NPS 2006a). Additional interagency and tribal consultation and planning and compliance may be necessary prior to these activities.

Collection and Rearing of Fish Humpback Chub Translocation Alternative 2

Humpback chub would be collected from the Little Colorado River during summer prior to monsoon onset (early to mid-July) or, if summer collecting trips are cancelled or ineffective due to flooding, a secondary collecting period would occur in fall (October or November). Trips would last approximately five days, and consist of six to eight biologists and volunteers. Equipment and staff would be flown into and out of previously established camps and landing areas via helicopter[14] (up to four flights to/from camps from Salt Helipad near the head of Salt Canyon). Collections would target young-of-the-year fish using netting methods.

Young-of-the-year humpback chub collected from the Little Colorado River would be flown from collection areas and transferred to a hatchery truck for delivery to a USFWS-approved hatchery facility. Fish would be quarantined and treated for parasites and diseases, following standard hatchery procedures, and held until approximately four inches (in five to ten months), then tagged and released the following spring or summer. The number of individuals collected per year would depend on population viability modeling (Pine et al. *in press*), genetic augmentation needs, and hatchery rearing capacity. Initially (the first five years, due to initial hatchery capacity), approximately 500 individuals would be collected for translocations per year.

Translocation/Release of Fish Humpback Chub Translocation Alternative 2

In late spring or early summer (the year after collection), tagged humpback chub would be flown from the NPS South Rim helibase in aerated coolers to release sites. Initially (the first five years), Havasu, Bright Angel, and Shinumo Creeks would be targeted for translocations; however, other tributaries, or areas of the mainstem Colorado River where sufficient habitat is determined to exist, may be considered for future

[14] Determined by GCNP's Minimum Requirement Analysis

translocations. Mainstem HBC aggregations (Valdez and Ryel 1995) would be targeted for translocations. Translocations in Shinumo Creek would be expanded to include another 0.6 mile (one km) of stream below White Creek to increase existing population size. Humpback chub translocation to Bright Angel Creek would only occur if brown trout were reduced from 2010 baseline estimates by greater than 80%. Brown trout would be monitored and maintained at or below 20% of the baseline population size by additional removals as needed. Following USFWS guidance (USFWS/ DNFHTC 2010), initial translocations of at least 200 fish would occur to each release area for a minimum of five years, and up to ten years (one generation, minimum 1,000 fish), depending on fish availability for translocation.

Adaptive Strategies for Management, Outcomes, and Triggers **Humpback Chub Translocation** **Alternative 2**

Various Outcomes from humpback chub translocation into tributaries or mainstem areas would be anticipated. For humpback chub, three potential HBC Outcomes would be expected (see Table 2.1).

Table 2.1 Humpback Chub, Possible Outcomes from Translocations, Alternative 2

Outcome	
HBC 1	Establishment of a second spawning and recruiting population in the mainstem or tributary
HBC 2	Sufficient survival and growth to provide a rearing ("grow-out") opportunity to augment the local mainstem aggregation
HBC 3	Failure of at least 20% of HBC to survive in the creek or adjacent mainstem aggregation for at least one year

The NPS and its cooperators would strive to meet HBC Outcome 1, which would contribute the most toward humpback chub recovery goals; however, HBC Outcome 2 would result in benefits to humpback chub. HBC Outcomes 2 and 3 would be evaluated five years following initial translocations. However, it may require ten years or more (Pine et al. in press) to determine whether HBC Outcome 1 has been observed.

Indicators for evaluation of potential humpback chub Outcomes are listed in Table 2.2.

Table 2.2 Humpback Chub, Indicators for HBC Outcomes, Alternative 2

Indicator	
A	Retention of translocated humpback chub over the first year
B	Similar or increased juvenile survival relative to the Little Colorado River and mainstem Colorado River near the Little Colorado River inflow
C	Similar or increased growth rates relative to the Little Colorado River and mainstem Colorado River near the Little Colorado River inflow
D	Contribution to and retention of translocated fish to an adjacent mainstem aggregation
E	Evidence of successful reproduction (presence of larval or young-of-year fish)
F	Evidence of recruitment to mature size

HBC Outcome 1 would be achieved if monitoring detected conditions described in HBC Indicators E or F. HBC Outcome 1 would trigger additional humpback chub translocations to maintain genetic integrity, consistent with genetics management principles found in DNFHTC (USFWS 2010) and Mills and Allendorf (1996). In summary, a minimum adult population of 200 fish would be maintained, with at least ten migrants per generation or it would be necessary to introduce ten additional adult fish into the population to maintain genetic integrity (Mills and Allendorf 1996). Based on observations made during translocations at Shinumo and Havasu Creeks (unpublished NPS data 2009-2012; Spurgeon 2012), and the number of fish remaining and surviving to adult size, between approximately 45 and 1,000 total fish may need to be released in translocation sites over a generation (a humpback chub generation is approximately ten years) (R. Valdez, SWCA consultations, personal communication to B. Healy/NPS, August 3, 2012).

HBC Outcome 2 would be achieved if monitoring detected conditions described in HBC Indicators A, B, C, or D for translocated populations. HBC Outcome 2 may be considered intermediate and expected to lead to HBC Outcome 1, which would be determined through continued monitoring. Alternatively, the particular translocation project for which HBC Outcome 2 would be observed for ten years may be considered a humpback chub rearing opportunity, in which case a minimum 200 adult fish would be maintained.

HBC Outcome 3 would signify translocation failure in partially or fully meeting FMZ objectives, and translocations to a particularly tributary or other mainstem area would cease. If at least HBC Indicator A had not been achieved consistently after five years of translocations, and no other HBC Indicators had been observed, then translocations to a particular area would be considered a failure (HBC Outcome 3), the translocation project would be re-evaluated and discontinued, if appropriate, following additional interagency and tribal consultation.

Monitoring **Humpback Chub Translocation** **Alternative 2**

A key component of this project element and adaptive management is monitoring translocated humpback populations' survival, individual fish growth, and reproduction and recruitment. Further, monitoring and augmentation of translocated populations may be necessary to maintain genetic integrity (USFWS/DNFHTC 2010).

Access to monitoring sites, ideally up to three times per year, would follow GCNP's Minimum Requirement Analysis process to minimize impacts to Proposed Wilderness. For tributary translocations, netting and/or electro-fishing may be necessary in both tributary and adjacent mainstem areas to determine humpback chub survival. Monitoring and continued control of non-native rainbow trout would also be employed during monitoring efforts at Shinumo Creek at least twice per year including a winter, one-week, raft-supported electro-fishing trip (February). No multiple-pass electro-fishing would occur in tributaries containing resident or transient populations of bluehead or flannelmouth sucker or humpback chub during April, May, or June to coincide with spawning periods. A temporary, previously installed fish detection system would be maintained for three more years to test release methods on humpback chub retention, and monitor movements of translocated fish at Shinumo Creek.

Razorback Sucker **Alternative 2**

Lower Colorado River FMZ Razorback Sucker Augmentation and Adaptive Management **Alternative 2**

Uncertainty exists as to whether GCNP habitat is suitable to maintain a self-sustaining razorback sucker population. Recent GCNP detections of razorback sucker tagged and released in Lake Mead, and their return to the lake suggests razorback sucker may use project area habitat at least occasionally. Further, as razorback sucker spawn and recruit in Lake Mead's Colorado River Inflow area, it is also possible populations will expand on their own into Lower Colorado River FMZ (RM 179.2 Lava Falls downstream to Lake Mead).

A three-year study, begun in 2010, in Lake Mead's Colorado River Inflow confirmed wild razorback suckers were spawning and recruiting into the Lake Mead fish population (Kegerries and Albrecht 2011). Recent data confirms razorback sucker sonic-tagged in Lake Mead have moved into the Colorado River FMZ at Quartermaster Canyon (R. Keggeries et al., Bio-West Inc, unpublished data). In addition, an untagged, ripe male was captured in the Colorado River FMZ in October 2012 (A. Bunch, AZGFD, personal communication). In consultation with the Lake Mead Razorback Sucker Workgroup, a razorback sucker management strategy was developed (Valdez et al. 2012a). The release of sonic-telemetry-tagged

razorback sucker is proposed, along with additional inventories to determine whether Colorado River FMZ habitat is suitable for razorback sucker.

Potential Outcomes related to razorback sucker suitability studies in Colorado River FMZ over the life of the plan are summarized in Table 2.3.

Table 2.3 Razorback Sucker (RBS), Potential Outcomes from Suitability Studies in Colorado River FMZ

Outcome	
RBS 1	Razorback sucker are present and reproducing in Colorado River FMZ
RBS 2	Razorback sucker are present in substantial numbers in Colorado River FMZ, but are not reproducing or recruiting in the Colorado River
RBS 3	Suitable razorback sucker habitat is available, but few individuals are present and no reproduction occurs

Depending on RBS Outcomes, elements of the phased adaptive management strategy described in Table 2.4 would be implemented.

Table 2.4 Razorback Sucker, Phased Adaptive Management Strategy, Alternative 2

Phase	Year	Action
I	1-3	Conduct fish community survey of Colorado River FMZ including larval fish, large-bodied fish, and sonic-tagged razorback sucker to describe/quantify fish community and identify potential spawning sites
II	End of Year 3	Evaluate data collected years 1-3 to identify • whether sonic-tagged fish remained in the area • razorback sucker presence/absence • whether the Lake Mead population is expanding into Grand Canyon
III	4	If Phase II results show substantial numbers (25%) of sonic-tagged razorback sucker remain, or razorback sucker presence (larvae or other unmarked adults), or evidence of Lake Mead's population expanding into Grand Canyon, then establish a long-term monitoring program for razorback sucker in Colorado River FMZ, and • Suspend plans to augment razorback sucker in Colorado River FMZ if evidence of increasing abundance of razorback sucker or expansion of Lake Mead population into Colorado River FMZ (RBS Outcome 1) or • Convene established workgroups (see Valdez et al. 2012a) to recommend continuing augmentation plan and implementation when there is a continued presence of Lake Mead razorback sucker but no evidence of expansion into Grand Canyon (RBS Outcome 2)

Non-native Fish and AIS

Introduction Prevention, Detection, and Control **Non-native Fish and AIS** **Alternative 2**

Outreach **Non-native Fish and AIS** **Alternative 2**

Outreach via development and placement of signs at likely public access points, website development, interpretive talks, and other materials or practices would be expanded to prevent accidental or purposeful introduction of new non-native aquatic species in the project area. Outreach efforts would also encourage harvest of all non-native fish species by anglers when appropriate.

Detection Monitoring **Non-native Fish and AIS** **Alternative 2**

Current fish and invertebrate monitoring conducted by cooperating agencies would continue at likely introduction areas in the Glen Canyon Reach, the Little Colorado River, and in the mainstem Colorado River upstream of Lake Mead. However, detection programs would be added or expanded to include other geographical areas considered high-risk pathways for non-native species introductions. Monitoring programs in tributary watersheds that include lands beyond the NPS boundary, and thus may be sources for new introductions including Havasu Creek and Kanab Creek would be added, with monitoring taking place on NPS-managed lands. Havasu Creek would be monitored using multiple fish-sampling gear types up to twice per year in conjunction with humpback chub monitoring (no additional trips), and Kanab Creek's lower sections would be monitored early summer and fall to detect non-native species in conjunction with river trips supporting monitoring efforts at Shinumo Creek or other tributaries. Fish monitoring efforts would be expanded in Colorado River FMZ to detect invading or expanding populations of non-native fish from Lake Mead in conjunction with efforts to monitor for razorback sucker (see Table 2.4).

When new introductions of non-native fish species are encountered, depending on level of threat and magnitude of response needed, control measures may take place through Emergency Response procedures (see Chapter 2, Emergency Rapid Response, Non-native Fish and AIS, Alternative 2).

To the extent possible, NPS would coordinate with other management agencies, tribes, and/or land owners in watersheds that extend beyond GCNP or GCNRA to evaluate risk of new introductions from those areas and develop cooperative efforts to deter future invasions.

Removal of Incidental Captures **Non-native Fish and AIS** **Alternative 2**

Under all Action Alternatives, unless specific research objectives warrant tagging and release, all high-risk non-native predatory fish species captured during monitoring efforts project-wide would be euthanized and put to beneficial use, when possible, according to consultation with Traditionally Associated American Indian Tribes. These species include brown trout (*Salmo trutta*), catfish species (including bullheads), bass and sunfish (*Centrarchidae*), striped bass (*Moronidae*), cichlids (*Cichlidae*), perch and walleye (*Percidae*), and other rare non-native species not previously detected in GCNP or the Glen Canyon Reach (e.g., burbot, *Lota lota*).

Source Identification **Non-native Fish and AIS** **Alternative 2**

Tissues or bony parts of high-risk non-native fish removed incidental to monitoring efforts would be analyzed to determine source when possible and when funding is available. For example, the microchemistry of humpback chub otolith bones has been used to determine natal origin in Grand Canyon (Hayden et al. 2012). Additionally, the NPS would engage resource managers (AZGFD, USFWS, Tribes) or landowners in the watersheds immediately adjacent to GCNP and GCNRA to prevent future introductions of non-native species. Information sharing would assist managers in targeting areas if/when expanded or emergency control efforts are needed.

Targeted Angling, Non-native Fish Removal Trips **Non-native Fish and AIS** **Alternative 2**

Non-native fish removal excursions would be implemented through a non-commercial administrative permit[15], when necessary, to remove cold-water non-native fish, primarily rainbow trout using angling equipment, primarily in Marble Canyon and downstream (Paria Riffle to approximately RM 60). Other rare non-native species may be captured and removed as well.

[15] NPS 2006 Management Policies, Section 8.2.2.5, "Commercial fishing will be allowed only when specifically authorized by federal law or treaty right."

Emergency Rapid Response to Detected Expansion or New Non-native Species Introduction **Non-native Fish and AIS** **Alternative 2**

As in Alternative 1, and consistent with NPS Director's Order-12 (2001, Section 2.14, Emergency Actions), for emergencies including

a) discovery of expansion in distribution or abundance of an existing high-risk non-native species, particularly in sensitive areas for native fish (e.g., Havasu Creek or Little Colorado River Inflow areas); or
b) new detection of a rapidly spreading aquatic invasive species or non-native fish species

the Superintendent could approve a temporary, short-term, targeted removal effort to treat known occurrences of the new threat using mechanical methods including angling, electro-fishing, and passive (i.e., trap nets) or active (e.g., seining) netting. Simultaneously, additional planning and compliance may be considered if a long-term response, such as maintenance control using a variety of methods, would be necessary.

Comprehensive Brown Trout Control **Non-native Fish and AIS** **Alternative 2**

NPS fisheries biologists would expand past trout reduction activities (weir and tributary electro-fishing, NPS 2006c) in Bright Angel Creek to the Bright Angel Creek Inflow area of the Colorado River. Both brown and rainbow trout and other non-native fish encountered would be removed during these efforts to meet goals and objectives identified in Chapter 1. Experimental mechanical control methods would be implemented for five consecutive years and then re-evaluated to determine whether reduction targets and native species objectives had been achieved. Integrated project activities would include

- Multiple-pass electro-fishing using two motorized electro-fishing boats for up to 20 nights, sufficient to reduce trout by at least 80% between Zoroaster and Horn Creek rapids (approximately five miles of the Colorado River). A single trip is proposed during fall
- Weir (fish trap) installation downstream of Phantom Ranch during spawning seasons for rainbow (fall/winter/spring) and brown trout (fall) to capture mature adults entering Bright Angel Creek to spawn. The weir may be installed in late summer or early fall and extend into spring months (April) depending on ability of equipment to withstand higher spring snowmelt runoff flows
- Backpack electro-fishing by an eight-person crew in all fish-bearing waters in the Bright Angel Creek watershed (approximately 13 miles of stream) for between approximately 70 and 100 continuous days over fall and winter. One remote camp and helicopter transport[16] of gear may be necessary near Bright Angel Canyon and in Bright Angel Creek headwaters
- Removing brown trout incidentally captured throughout the project area during monitoring (see Comprehensive Brown Trout Control), and encouraging harvest of brown trout by anglers. Through adaptive management, anglers may be encouraged to harvest brown trout via public outreach activities, changes in harvest regulations, or other means. Additional consultation may be necessary
- Mechanical removal (electro-fishing, angling, netting, etc.) of brown trout may be employed in other tributaries or mainstem areas if natal origin studies conducted during the first five years indicate other areas are sources of brown trout in Grand Canyon, and project-wide declines in brown trout are not observed initially. Efforts would be focused where individuals are aggregating and populations can be feasibly controlled and suppressed using mechanical removal methods (additional planning and compliance may be necessary)

Monitoring would occur annually to determine project success during and following the initial five-year effort. Monitoring metrics include abundance, size structure, and recruitment of native and non-native species, as well as apparent survival of bluehead sucker (may require additional sampling occasions).

[16] Determined by GCNP's MRA

Depletion monitoring using electro-fishing gear would be the initial focus for both the tributary and Colorado River; however, additional netting may be conducted in both areas in coordination and consultation with the AZGFD, USFWS, and GCMRC to improve native fish survival or abundance estimates.

Adaptive Management, Outcomes, and Triggers **Non-native Fish and AIS** **Alternative 2**

Non-native fish control is proposed in Alternative 2 to benefit GCNP native fish species (see Chapter 1 GCNP Goal 2); however, the response of native fish to non-native control actions, and the level of control necessary to elicit a positive response in native populations is difficult to predict and variable (reviewed by M. Trammell, unpublished report 2005). While measures are taken to reduce likelihood of injury to individual native fish during electro-fishing, fish injuries or deaths can and do occur on occasion. The uncertainty relates to whether benefits to native fish populations of removal of non-native predators outweigh potential effects of injury to individual fish through electro-fishing and subsequent handling prior to release. Additionally, environmental factors (e.g., climate, flooding, drought, fire, etc.) not influenced by active management may have an overriding influence in driving native fish population dynamics in project area waters. Potential outcomes for non-native fish removal activities for both existing native and non-native fish in tributaries are summarized in Table 2.5.

Table 2.5 Potential Outcomes for Non-native Fish (NNF) Removal for Existing Native and Non-native Fish

NNF 1	Native fish survival, abundance, and recruitment is maintained or increases as non-native fish species abundance is reduced in tributaries
NNF 2	Native fish survival, abundance, and recruitment declines as non-native fish species abundance is reduced in tributaries
NNF 3	Non-native fish abundance does not decline in tributaries with control method implementation

Non-native fish and native bluehead sucker and speckled dace population dynamics would be monitored in all tributaries where non-native fish control actions would be implemented. A monitoring program is currently in place (see Alternative 1) for these species in Havasu, Shinumo, and Bright Angel Creeks. Flannelmouth sucker are not generally found as residents in tributaries outside the Little Colorado River, and thus, monitoring efforts in tributaries may be focused on other native species (speckled dace and bluehead sucker). Flannelmouth sucker trends in GCNP and the Glen Canyon Reach are monitored during AZGFD's and USGS-GCMRC's mainstem electro-fishing trips on the Colorado River between Lees Ferry and Lake Mead, and during Glen Canyon electro-fishing monitoring efforts. Only abundance indicators (Table 2.6) are proposed for monitoring speckled dace due to lack of feasible methods to assess individual survival for the species. Outcomes for each non-native control project would be assessed after five years, using indicators described in Table 2.6.

Table 2.6 Non-native Fish, Indicators for NNF Outcomes, Alternative 2

Indicator	
A	Measures of abundance or density (e.g., relative abundance: number of fish/unit area) or trend in catch rates (i.e., catch-per-unit-effort)
B	Survival (estimated via mark-recapture)
C	Recruitment (either number of new fish tagged or percent of population less than 100 or 150 mm)
D	Size structure (i.e., numbers of fish at each size class)

Fisheries managers would strive for NNF Outcome 1 for each project, and if achieved, non-native control projects may proceed at an appropriate level of maintenance control effort, which could include continued or reduced effort.

If after five years, monitoring indicates that NNF Outcome 2 or 3 has occurred, non-native fish control projects would cease and be re-evaluated for at least one year. Data and trends from previous years and newly emerging science and technologies would be reviewed, and methods may be adapted for the future to achieve NNF Outcome 1. Translocations of other native species may be considered if it is determined species declines are severe, and augmentation is needed. Following review, and depending on the most appropriate course of action proposed, additional planning and compliance may be necessary.

During the evaluation phase of non-native fish control projects, NPS would share data, results, and future plans with collaborating agencies, Traditionally Associated American Indian Tribes, stakeholders, and interested public.

Feasibility Study for Use of Chemical Fish Control Methods — **Non-native Fish and AIS** — **Alternative 2**

Data to assess use of chemical fish control methods were not available during preparation of this CFMP EA. Aside from stream dewatering, chemical piscicides (fish poisons) may be the only means to ensure complete removal of non-native fish species from streams (Moore et al. 2008). During implementation of initial five-year mechanical non-native fish removal efforts for brown trout, additional data would be collected to determine chemical use feasibility, and possibly barrier installation for trout control in Bright Angel Creek and other tributary streams. Data collection for invertebrates, water quality, distribution of native and non-native fish species and non-target organisms, and physical habitat would be guided by published NPS guidance for the use of chemical piscicides (see Moore et al. 2008). Future potential use of chemical fish control methods would also be informed through interagency and tribal consultation. Additional NEPA documentation, planning, and accompanying compliance would be necessary if chemical means for controlling non-native fish in GCNP are considered in the future.

Beneficial Use of Non-native Fish Removed — **Non-native Fish and AIS** — **Alternative 2**

The NPS would employ a beneficial use policy for all non-native fish removed from the project area following consultation with Traditionally Associated American Indian Tribes. Beneficial use policies would be employed to reduce disease-transfer risk from one location to another, consistent with state and federal laws and statutes. Non-native fish euthanized during non-native control efforts would be put to a beneficial use, to the extent possible, and within limits of health and safety for human consumption, fed to captive wildlife at wildlife rehabilitation centers, or recycled into the ecosystem through returning fish into the water following euthanization.

Glen Canyon Rainbow Trout Management — **Glen Canyon Rainbow Trout** — **Alternative 2**

Sterile Trout Experimental Stocking — **Glen Canyon Rainbow Trout** — **Alternative 2**

NPS 2006 Management Policies (NPS 2006, Section 4.4.3) allow for exotic species stocking for recreational fishing in altered water bodies when allowed by law, such as in GCNRA's enabling legislation, when the activities will not result in unacceptable impact to park natural resources or processes. Sterile trout would not reproduce, and could be stocked in an experimental context to maintain GCNRA fishing opportunities. Experimental stocking of sterile, triploid rainbow trout (stocking plan to be determined) could be initiated, specifically if one or more elements in Table 2.7 are met.

Table 2.7 Glen Canyon Reach Rainbow Trout Experimental Stocking Criteria

• Recruitment (wild young fish) is low for multiple years: rainbow trout recruits (fish less than six inches) comprise less than 20% of the fish community during AZGFD fall monitoring events for more than three consecutive years; or
• AZGFD electro-fishing estimates of relative abundance are less than one fish/minute for two consecutive years of fall sampling; or
• If angler catch rates in Glen Canyon Reach decline to less than or equal to 0.5 rainbow trout/hour, and average size less than 14 inches for two consecutive years; in other words, if trout density and angler catch rates are very low, but average fish size is very large, then goals for the fishery would have been met and no sterile triploid trout stocking would be necessary

Sterile rainbow trout stocking would be limited to the Glen Canyon Reach. Stocking would likely continue until electro-fishing relative abundance estimates and/or angler catch rate criteria in Table 2.7 are met. Relative abundance of all fish caught would be greater than one fish/minute or angler catch rates exceeded 0.5 fish/hour for two consecutive years. Depending on conditions that may lead to a potential decline in the fishery in the future, sterile trout may be stocked for a number of years until the fishery objectives are met (Chapter 1), at which time stocking would potentially cease until triggers are met, and stocking would be re-initiated. Stocking could be reinitiated as appropriate, following GCNRA's rainbow trout adaptive management strategy described in the next paragraph.

Adaptive Management Glen Canyon Rainbow Trout Alternative 2

A stocking and monitoring plan including number and size of sterile trout stocked would be developed before sterile trout stocking would be implemented. At a minimum, sterile fish released would be marked to assess their performance. Short- and long-term Outcomes, monitoring metrics, and an adaptive management framework would be defined and determined. Depending on the final stocking and monitoring plan, additional planning and compliance may be necessary. For example, experimental stocking of triploid rainbow trout would include extensive marking of hatchery fish to monitor multiple metrics including, but not limited to, return to anglers, movement, growth, and survival. If marked fish are not returned/captured by anglers as intended or are found moving out of the stocking-approved area (i.e., into Marble Canyon/Little Colorado River area), stocking would be reassessed. Reassessment could include altering location of stocking, size of fish stocked, timing of stocking, and number of fish stocked. If stocking was deemed sustainable at a given level (i.e., acceptable catch rates, minimal impacts outside the fishery), it would continue. Essentially, the experiment would be successful if, through triploid trout stocking, fisheries objectives could be maintained and an adequate control of the rainbow trout population could be achieved while minimizing impacts on resources outside the fishery. If, through monitoring of stocked fish, there is minimal return to anglers or unacceptable levels of impact on resources outside the fishery, stocking would cease.

Extirpated Species Extirpated Species Alternative 2
Reintroduction Feasibility Studies

Feasibility studies for extirpated fish species reintroduction would be conducted over the life of the plan, and if potential exists, additional NEPA, ESA, NHPA and associated planning and compliance would be initiated prior to reintroduction plan development. Prior to summer 2012, razorback sucker had not been detected in the project area since the 1990s, and was considered extirpated. However, since 2012, five tagged razorback sucker were found upstream of Pearce Ferry Rapid (River Mile 280) including four detected in GCNP upstream of River Mile 277.4 (B. Albrecht, BIO-West, Inc., personal communication), and another individual captured in October 2012 near Spencer Canyon (RM 246) (A. Bunch, AZGFD, personal communication). Thus, razorback sucker is no longer considered extirpated (see Chapter 3).

At this time, only Colorado pikeminnow would be prioritized for reintroduction feasibility studies. Potential hybridization between roundtail chub, bonytail, and humpback chub preclude introduction of additional chub species (*Gila* sp.) in humpback chub habitat. Pikeminnow reintroduction feasibility studies would primarily rely on expert opinion, literature reviews of habitat requirements, and evaluation of existing biological and physical data (e.g., food base, fish community). However, a field survey may also be required to assess physical habitat or collect biological data.

ALTERNATIVE 3 INTENSIVE FISHERIES MANAGEMENT

The emphasis of Alternative 3 is on more intensive management of non-native fish species in GCNP than in Alternative 2. Actions described under Alternative 1 would continue under this Alternative as would several actions described in Alternative 2 including those under the headings Razorback Sucker Augmentation and Management, Glen Canyon Rainbow Trout Management, and Extirpated Species Reintroduction Feasibility Studies.

The primary difference between Alternative 3 and Alternative 2, is that Alternative 3 proposes a higher level of intensity in humpback chub translocations and non-native fish and AIS introduction prevention, detection, and control. These differences are described here.

Humpback Chub Translocations Humpback Chub Alternative 3

Shinumo Creek
Humpback chub translocations would differ slightly from Alternative 2 by including expansion of non-native control and translocation efforts to Shinumo Creek's lower 4.7 miles (7.5 km) (1.9 miles [3 km] in Alternative 2). Shinumo Creek rainbow trout control would be expanded to include areas upstream of past control efforts (from below White Creek), and would be conducted from a remote base camp near the White Creek confluence. The site would be accessed annually in fall/winter, and would be supplied via a combination of hiking and helicopter support. Multiple-pass backpack electro-fishing would be used by a crew of eight from an area of Shinumo Creek adjacent to historic Bass Camp (approximately 1.7 [2.8 km] from the mouth) and extend to a waterfall above the confluence with Flint Creek (approximately 4 miles [7.5 km] from the mouth). A five-year initial electro-fishing effort would be employed, followed by humpback chub translocations if rainbow trout are reduced by 80% of baseline numbers (based on initial population estimates to be determined) and maintained at low abundance. Trout control and humpback chub translocations would be implemented in the same adaptive management context as described under Alternative 2.

Non-native Fish and AIS Introduction Prevention, Detection, and Control Non-native Fish and AIS Alternative 3

Removal of Incidental Captures Non-native Fish and AIS Alternative 3
As in Alternative 2, high-risk non-native predatory species listed under Removal of Incidental Captures in Alternative 2 would be removed if captured during project area monitoring efforts, but under Alternative 3, common carp would also be removed.

Proactive Non-native Fish Control Non-native Fish and AIS Alternative 3
Proactive control of non-native warm-water predators such as striped bass, channel catfish, common carp (native fish egg predators) and others would be focused on three project area locations: the Little Colorado River near its mouth, Havasu Creek and its inflow to the Colorado River, and areas below Lava Falls. A variety of fishing gear types would be used in all areas including passive and active netting, electro-fishing (backpack and boat-mounted), and angling. Non-native control in Colorado River FMZ

(i.e., below Lava Falls) would be focused on areas near tributary inflows, and may also include encouraging volunteer angling to remove catfish. The NPS would explore potential for a catfish angling opportunity coordinated with the Hualapai Tribe below Diamond Creek.

In Havasu Creek itself, angling equipment (barbless hooks only) would be used to attempt to remove rainbow trout in conjunction with humpback chub translocation monitoring trips (two per year).

The adaptive management approach to evaluate non-native control efforts described for Alternative 2 above would be followed for these control efforts as well.

Comprehensive Brown Trout Control Non-native Fish and AIS Alternative 3
Brown trout control differs from Alternative 2 in that it includes a second mainstem, boat-based electro-fishing removal trip (up to 20 days) in April/May of each year for five years, initially. A total of 40 days of electro-fishing would occur in this reach to remove trout and other non-native fish species.

ALTERNATIVES CONSIDERED AND DISMISSED

The following Alternatives were considered for project implementation, but were ultimately dismissed from further analysis. Reasons for their dismissal are provided in the following descriptions.

Avoid Non-native Fish Control or Removal Alternatives Considered and Dismissed
This Alternative would not meet Chapter 1's Purpose And Need of restoring native fish communities and reducing threats to endangered humpback chub in GCNP, or improving and maintaining a highly valued recreational rainbow trout fishery in the GCNRA's Glen Canyon Reach . Non-native predators are established throughout the project area, resulting in altered fish communities in which native species cannot proliferate. USFWS Recovery Goals for endangered humpback chub (2002) cannot be met until non-native fish control strategies are developed and implemented for brown trout, channel catfish, black bullhead, and rainbow trout.

In addition, this Alternative is not consistent with NPS 2006 Management Policies (Section 4.4.4, NPS 2006a), which states:

- Exotic species will not be allowed to displace native species if displacement can be prevented
- All exotic plant and animal species will be removed, up to eradication if they can be controlled, and the exotic species poses a threat to native species
- Where an exotic species cannot be successfully eliminated, managers will seek to contain the exotic species to prevent further spread or resource damage

Live Removal of Non-Native Fish Alternatives Considered and Dismissed
Non-native fish live removal and transfer from the project area has been suggested through consultation with Traditionally Associated American Indian Tribes and during public scoping. The pathogen responsible for whirling disease (*Myxobolus cerebralis*) was first detected in trout in the Glen Canyon Reach in 2007, and was more prevalent in the area during 2011 testing. This pathogen can cause infected fish to swim in an uncontrolled whirling motion and lead to death in rainbow trout. The aquatic invasive species New Zealand mud snail (*Potamopyrgus antipodarum)* and the diatom Didymo (*Didymosphenia geminata*) are present in waters in the project area.

Live removal of trout from Grand or Glen Canyon is not being considered due to resource concerns including

- State (ARS §17-255) and federal law prohibits transfer of live fish from disease infested waters

across the state and into other state waters. In Arizona, whirling disease, Didymo (aka rock snot), and New Zealand mudsnail are only found in the Glen Canyon Reach

- Logistically, it may be impossible to remove large numbers (more than a bucketful) of live trout from remote canyon areas, transfer them, temper them, and release them alive. Wild trout are somewhat delicate, and mortality normally occurs from field handling during monitoring efforts under some conditions

Glen Canyon Mechanical Removal of Small Rainbow Trout **Alternatives Considered and Dismissed**

To meet objectives for GCNRA rainbow trout fishery and GCNP native fish communities, evaluation and implementation of large-scale mechanical removal of young-of-the-year or juvenile rainbow trout (fish less than six inches) was proposed when high-recruitment indicators triggered the action. Based on capture efficiency estimates for electro-fishing small rainbow trout in the Glen Canyon Reach at high densities (2011, J. Korman, unpublished data), this action may have required 50 to 100 days of continuous electro-fishing along the shoreline upstream of Lees Ferry with two electro-fishing boats during fall to reduce juvenile trout density by 50 or 60%, in order to meet size structure and growth objectives.

NPS and AZGFD specialists agreed GCD's influence on rainbow trout population dynamics would be greater than any feasible mechanical-control scenario. Therefore, factors that influence rainbow trout population dynamics such as GCD water flow volume, temperature, and release timing confound project evaluation.

The feasibility of this action and response of the remaining rainbow trout population are somewhat uncertain, and related potential impacts and controversy exceed the scope of this EA.

Chemical Removal of Non-Native Fish and Fish Passage Barrier Construction **Alternatives Considered and Dismissed**

This Alternative would use chemical control (piscicides) to eliminate trout and other non-native fish from selected tributaries. Piscicides are relatively non-toxic to humans and non-fish wildlife. Short- and long-term responses of aquatic invertebrate communities to piscicide treatments (rotenone and antimycin) have been variable. The effects of treatments depend on factors such as the concentration and duration of treatments, reproductive biology and dispersal ability of individual invertebrate species, and the presence of and distance from treatment areas to a source area for re-colonization of treatment areas following post-treatment (Vinson et al. 2010). Piscicides are often used in combination with a fish passage barrier (either natural or constructed) to prevent reinvasion of habitats by target non-native species once treatment is applied.

Piscicide and barrier construction were eliminated from detailed study due to insufficient data to assess potential impacts to park resources associated with chemical control of non-native fish in streams. In addition, preliminary evaluation of barrier construction feasibility in Bright Angel Creek suggested construction and maintenance would be logistically difficult, and that further detailed study was needed. Flood resiliency and maintenance concerns related to a fish passage barriers were raised the NPS Interdisciplinary Team during site visits. Nevertheless, piscicides may be considered in the future depending on mechanical control results and future feasibility studies. Additional NEPA, ESA, NHPA and associated planning and compliance would be addressed at that time.

Flow Modification and Tributary Dewatering **Alternatives Considered and Dismissed**

Colorado River flow into Glen Canyon Reach and GCNP is controlled by GCD. Water flow timing and amount is regulated by the U.S. Bureau of Reclamation under the 2007 Colorado River Interim Guidelines (USBR 2007) and 1996 and 2007 Records of Decision (USBR 1996 and 2007). None of the

Alternatives analyzed in this CFMP EA propose modifications to GCD or its operations because NPS does not have discretion to determine dam operations. The NPS is a co-lead with the USBR for the LTEMP EIS, and will address potential operational considerations in that process.

Paria River Pond Construction **Alternatives Considered and Dismissed**

Construction of ponds near the confluence of the Colorado and Paria Rivers was suggested for several reasons. Ponds could support efforts to rear and restore native fish, conduct research, or provide fishing opportunities using trout removed from the Colorado River or its tributaries. The project would constitute a major construction project requiring water diversions, fill dredging and deposition, long-term maintenance, and care of fish once stocked. This Alternative was dismissed because impacts to riparian and other resources are beyond the scope of this EA. In addition, the project may not meet Chapter 1's Purpose and Need for restoration of native fish communities, and other restoration efforts were determined more appropriate.

Aquatic Food Web Enhancement or Introduction of Insects to Enhance Foodbase **Alternatives Considered and Dismissed**

NPS 2006 Management Policies dictates only native extirpated species will be reintroduced to NPS units (Section 4.4.4.1, NPS 2006a) unless allowed by enabling legislation, and if appropriate habitat is available or can be reasonably restored (Section 4.4.2.2, NPS 2006a). Un-impounded areas of the Colorado River with minimally or less-impaired habitat (Cataract Canyon) can be considered a reference condition for a native aquatic insect community. Many native species extirpated from the mainstem (when GCD was constructed) require seasonally fluctuating temperatures including a period of near-freezing temperatures to complete their life cycle. This temperature regime cannot be reasonably replicated in the Colorado River currently, and thus habitat cannot be reasonably restored for these species with potential actions (non-dam related) included in this EA.

Include Lake Mead National Recreation Area **Alternatives Considered and Dismissed**

The main focus of the CFMP is on native fish management needs in GCNP and the recreational trout fishery in the Glen Canyon Reach. Razorback sucker reintroductions, in coordination with the Lake Mead Razorback Sucker Workgroup, and management of warm-water non-native species that may invade GCNP from Lake Mead are considered in the CFMP EA. To include the remaining Lake Mead or Lake Powell fisheries in this planning process would increase the scope and complexity of the plan beyond the purpose and need for the CFMP described in Chapter 1 (Introduction).

Stocking Additional Trout Species in the Glen Canyon Reach **Alternatives Considered and Dismissed**

A comment received during scoping suggested stocking Apache trout, a native trout species to parts of Arizona (outside the project area) and listed as threatened under the Endangered Species Act, in the Glen Canyon Reach to provide Apache trout conservation and an additional sport fishing opportunity. However, NPS 2006 Management Policies (Section 4.4.4.1, NPS 2006a) dictates that, in general, new exotic species will not be introduced into parks unless the exotic species meets a specific, identified management need, all feasible and prudent measures to minimize risk of harm have been taken, and the action meets several other criteria (e.g., stocking is allowed by law). Effects of such an introduction on native fauna are difficult to predict including potential for impact on endangered humpback chub in connected waters in Grand Canyon and downstream, and thus, this element was not carried forward.

COMPARISON OF ALTERNATIVES

Table 2.7 includes a summary of ongoing management actions (Alternative 1), as well as activities proposed under Action Alternatives 2 and 3. Ongoing and future research proposals conducted through the GCDAMP are not included here, as they are part of a separate permitting, planning, and compliance process.

Table 2.8 Elements of Alternatives

Alternative Elements	Alternative 1 No Action Current Management	Alternative 2 Moderate Intensity Fisheries Management	Alternative 3 Intensive Fisheries Management
Entire Project Area			
Outreach/AIS prevention	Educational outreach continues; current operations remain unchanged	Same as Alternative 1	Same as Alternative 1
Expanded non-native species detection monitoring	No	Expanded to Lower Colorado River, and Kanab and Havasu Creeks	Same as Alternative 2
Emergency response to new/expanded introductions	Emergency response procedures remain; current operations remain unchanged	Same as Alternative 1	Same as Alternative 1
Remove incidental captures	Minimal, only rare non-natives removed	Rare non-natives and Catfish, brown trout, bass, sunfish, percids removed	Same as Alternative 2 plus common carp removed
Proactive warm-water non-native fish control	No	Same as Alternative 1	Proactive control of catfish, bass, and others
Beneficial use of removed non-native fish	Removed fish go to beneficial use	Same as Alternative 1	Same as Alternative 1
Angler harvest regulations	Current regulatory agency procedures unchanged	Same as Alternative 1	Same as Alternative 1
Extirpated species reintroduction feasibility studies	No	Yes	Same as Alternative 2
GCNP			
Little Colorado River and Inflow FMZ			
Juvenile humpback chub collected for tributary translocations	No	Collected fish reared in hatchery, marked, and released in tributaries or downstream areas of the Colorado River in GCNP	Same as Alternative 2
Marble Canyon FMZ			
Targeted volunteer angling-facilitated river trips with mandatory harvest of rainbow trout	No	Non-commercial trips in Marble Canyon and downstream (Paria Riffle to RM 60)	Same as Alternative 2
Bright Angel Creek and Inflow FMZ			
Tributary non-native fish control electro-fishing	None	NPS 2006c experimental actions extended additional five-plus years	Same as Alternative 2
Weir operations (fall/winter)	None	NPS 2006c experimental actions extended additional five-plus years	Same as Alternative 2
Boat-electro-fishing trout control	No	One trip/year (November)	Two trips/year (November and April)
Humpback Chub translocations	No	Translocations continue if trout removal targets met	Same as Alternative 2
Native fish translocations (triggered)	No	Yes	Same as Alternative 2
Shinumo Creek and Inflow FMZ			
Tributary non-native fish control electro-fishing and/or angling	None	Applied to up to 2.5 miles (4 km) of stream during 2-3 monitoring trips/year	Applied to up to 4.4 miles (7 km) of stream during 2-3 monitoring trips/year

Alternative Elements	Alternative 1 No Action Current Management	Alternative 2 Moderate Intensity Fisheries Management	Alternative 3 Intensive Fisheries Management
			and 2 or more helicopter/river supported-trips per year
Humpback chub translocations	None	Minimum two more years in 2.5 miles (4 km) of habitat according to genetics augmentation plan	Same as Alternative 2 in 4.4 miles (7 km) of habitat
Remote PIT tag antenna maintenance	Existing antenna removed	Antenna maintained and used 3 more years	Same as Alternative 2
Native fish translocations (triggered)	No	Expanded to another 0.6 miles (1 km) of stream below White Creek	Same as Alternative 2
Havasu Creek and Inflow FMZ			
Humpback chub translocations	No	Minimum two more years according to genetics augmentation plan	Same as Alternative 2
Native fish translocations (triggered)	No	Only as needed per established criteria	Same as Alternative 2
Tributary non-native fish control (netting/angling)	No	Incidental to monitoring	Proactive approach in tributary, netting/angling
Mainstem/Inflow non-native fish control (boat electro-fishing/angling) for striped bass, catfish	No	Only as needed per established criteria	Proactive approach
Lower Colorado River FMZ			
Razorback sucker augmentation/ management (Lava Falls to Lake Mead)	Limited monitoring only	Phased approach: 1) Sonic tagging/tracking adults, larval fish study. 2) Assess results, develop long-term monitoring/ augmentation plan if appropriate	Same as Alternative 2
Coordinate trips to harvest catfish and other warm-water species using angler volunteers from below Diamond Creek to LAKE	No	Same as Alternative 1	Catfish angling opportunity coordinated with Hualapai Tribe below Diamond Creek
Colorado River Mainstem FMZ			
Fisheries Monitoring	Current monitoring programs continue unchanged	Adaptive management based on existing monitoring programs	Same as Alternative 2
Humpback Chub translocations to aggregations	None	2011and 2013 USFWS conservation measures implemented	Same as Alternative 2 and expanded to include additional sections of Shinumo Creek plus associated electro-fishing
Other Tributaries			
Non-native control mechanical (netting, angling, electro-fishing)	Only if emergency response is triggered, or pending further Section 106, NEPA, and ESA planning and compliance	Same as Alternative 1	Same as Alternative 1
GCNRA **Glen Canyon Reach**			
Management of existing trout size structure/density	Current operations will remain unchanged	Same as Alternative 1	Same as Alternative 1
Experimental stocking triploid/sterile trout	No	Sterile rainbow trout stocked upstream of Paria Riffle if criteria met. Angler catch rates will be monitored and regulated	Same as Alternative 1

Table 2.9 Environmental Impact Summary by Alternative

Impact Topic	Alternative 1 No Action Current Management	Alternative 2 Preferred Moderate Intensity Management	Alternative 3 Intensive Management
Glen Canyon Trout Fishery	Minor, beneficial, localized, short-term, OR minor to moderate, adverse, local, long-term (depending on effects of whirling disease, etc.)	Minor to moderate, beneficial, local, and short- to long-term	Same as Alternative 2
Grand Canyon Native Fish	Minor to moderate, adverse, long-term, local	Minor to moderate, beneficial, local, long-term	Moderate, beneficial, local, long-term
Ethnographic Resources	Moderate, adverse, regional, long-term	Moderate, adverse, regional, long-term	Same as Alternative 2
Visitor Use and Experience	Minor to moderate, adverse, short-to long-term	Minor to Moderate, adverse, local, short- to long-term due to encounters with crews and for angling experience in GCNP	Moderate, adverse, local, short- to long-term impacts due to encounters with crews and for angling experience in GCNP
		Moderate, beneficial, local, short- to long-term for restoration of native ecosystems in GCNP and angling in GCNRA	Same as Alternative 2
Wilderness Character	Minor to moderate, adverse, local, short and long-term for untrammeled, natural, undeveloped and unconfined recreation qualities	Same as Alternative 1	Same as Alternative 1
		Moderate beneficial, local and long-term for natural quality	Same as Alternative 2
	Minor beneficial, short-term, local to Wilderness education	Same as Alternative 1	Same as Alternative 1
Non-Fish Special Status Species	Minor, adverse, regional, long-term	Same as Alternative 1	Same as Alternative 1

Table 2.10 Summary of How Each Alternative Meets Proposed Objectives

Proposed Objectives	Does Alternative Meet Proposed Objective?		
	Alternative 1 No Action	**Alternative 2 Moderate Intensity Management**	**Alternative 3 Intensive Management**
Projectwide Objectives			
1. Monitor for, and respond to, new invasions and/or expanded range or relative abundance of non-desirable fish or AIS with feasible control measures	Yes, monitoring continues and emergency response procedures remain; no change from current operations	Yes, detection monitoring expanded in areas with highest risk of AIS/non-desirable fish introductions resulting in more effective responses (if needed)	Same as Alternative 2
2. Determine natal origin or introductions source of all warm-water (e.g., bass, catfish) and high-priority cold-water non-native species (brown trout), and develop and implement plans to control sources of those species	No	Yes, natal origin studies improve effectiveness of control efforts for brown trout and other non-native warm-water species	Same as Alternative 2
3. Implement beneficial use program for non-native species removed for native fish community restoration or ESA-listed fish recovery consistent with NHPA Section 106 consultation with Traditionally Associated American Indian Tribes	No (however, beneficial use would be applied to projects ending in 2013)	Yes, a majority of fish removed used beneficially by humans	Yes, however beneficial use (human consumption) would be more difficult to implement due to expanded control efforts
4. Conduct aquatic communities inventory in tributaries where data are unavailable, and develop and implement restoration plans, when necessary	No	Yes	Same as Alternative 2
5. Implement monitoring plan sufficient to assess changes in fish populations related to management actions or natural factors	Yes	Yes	Same as Alternative 2
GCNP			
Little Colorado River and Inflow FMZ			
1. Maintain adult abundance of humpback chub at or above the latest population estimate (6,000 to 10,000 adults) or above the minimum viable population size as determined by USFWS whichever is greater	No	Yes, comprehensive non-native trout control reduces predation pressure on juvenile native fish at LCR	Yes, comprehensive non-native trout control and proactive warm-water non-native fish control reduces predation pressure on juvenile native fish at LCR
2. Maintain stable or increasing populations of bluehead sucker, flannelmouth sucker, and speckled dace	No	Yes, comprehensive non-native trout control reduces predation pressure on juvenile native fish at LCR	Yes, comprehensive non-native trout control and proactive warm-water non-native fish control reduces predation pressure on juvenile native fish at LCR
Bright Angel Creek and Inflow FMZ			
1. Reduce and maintain abundance of non-native trout at approximately 20% of baseline over five years, to allow enhanced populations of native resident species	No	Yes, experimental comprehensive trout removal	Same as Alternative 2
2. Maintain stable or increasing populations of bluehead	No	Yes, removal of predatory trout	Same as Alternative 2

Proposed Objectives	Does Alternative Meet Proposed Objective?		
	Alternative 1 No Action	**Alternative 2 Moderate Intensity Management**	**Alternative 3 Intensive Management**
sucker, flannelmouth sucker, and speckled dace		allows for greater juvenile survival	
3. Following reduction of non-native species (brown trout), begin experimental humpback chub translocations to establish spawning aggregation with mature population increasing toward Bright Angel Creek's estimated carrying capacity or toward minimum viable population size in the Bright Angel Creek Inflow Aggregation, while maintaining genetic integrity	No	Yes, pending outcome of trout control	Same as Alternative 2
Shinumo Creek and Inflow FMZ			
1. Over the next ten years, establish humpback chub spawning aggregation with mature population increasing toward Shinumo Creek's estimated carrying capacity or toward minimum viable population size in the Shinumo Inflow Aggregation, while maintaining genetic integrity	May be partially met, depending on outcome of 2009-2011 translocations	Yes, continued translocations in an adaptive management context	Same as Alternative 2 and expanded trout control and translocations upstream would increase likelihood of success
2. Investigate Alternative release techniques and management strategies to improve retention and rearing of translocated humpback chub in Shinumo Creek and other tributaries where translocation may occur	No. No additional translocations implemented	Yes, continued maintenance of a PIT tag antenna and additional translocations	Same as Alternative 2
3. Maintain stable or increasing populations of bluehead sucker and speckled dace	No	Yes, trout control and translocations of native fish (if triggered) maintain/increase populations	Same as Alternative 2 and expanded trout control upstream would increase likelihood of success
Havasu Creek and Inflow FMZ			
1. Over the next ten years, establish a humpback chub spawning aggregation with the mature population increasing toward Havasu Creek's estimated carrying capacity or toward minimum viable population size in the Havasu Inflow aggregation while maintaining genetic integrity	May be partially met, depending on outcome of 2010-2013translocations	Yes, continued translocations implemented in an adaptive management context	Same as Alternative 2 and expanded proactive control of non-native species may increase likelihood of success
2. Maintain stable or increasing populations of bluehead sucker, speckled dace, and other native species	No	Yes, translocations of bluehead suckers or speckled dace (if triggered) maintain/ increase populations	Yes, native fish translocations implemented in adaptive management context. Expanded proactive control of non-native species may increase likelihood of success
Lower Colorado River FMZ			
1. Develop and implement razorback sucker management strategy below RM 179.2 (Lava Falls) coordinated with LAKE	No management strategies implemented	Yes	Same as Alternative 2
Colorado River Mainstem Objective FMZ			
1. Maintain stable or increasing populations of bluehead	No	Yes. Comprehensive brown trout	Yes. Comprehensive brown trout

Proposed Objectives	Does Alternative Meet Proposed Objective?		
	Alternative 1 No Action	**Alternative 2 Moderate Intensity Management**	**Alternative 3 Intensive Management**
sucker, flannelmouth sucker, and speckled dace		control contributes to meeting this objective in the Colorado River (downstream of LCR)	control, combined with proactive warm-water fish control contributes to meeting this objective in the Colorado River (downstream of LCR)
2. Evaluate potential for reintroducing native extirpated species and begin developing implementation strategies as appropriate	**No**	Yes	Same as Alternative 2
GCNRA			
Glen Canyon Reach Objectives			
1. Maintain angler catch rates of at least 10 fish per day greater than 14 inches, and angler catch rate above 1.0 fish per hour	No	Yes, potentially met through experimental stocking of sterile trout	Same as Alternative 2
2. Annually maintain proportion of rainbow trout less than 6 inches at 20-80% of the population, and maintain at least moderate condition of catchable size (greater than 12 inches) rainbow trout	No. Size structure and body condition continue to fluctuate depending on dam discharge, disease impacts, etc.	Same as Alternative 1	Same as Alternative 1
3. Maintain a rainbow trout fishery in the event of a severe decline in population through stocking of triploid rainbow trout of multiple age-classes	No	Yes, potentially met through experimental stocking of sterile trout	Same as Alternative 2
4. Promote take of all undesirable non-native fish by anglers including but not limited to: brown trout, walleye, and sunfish to prevent potential impacts to rainbow trout fishery and native fish populations downstream in GCNP	Yes. Angler harvest promoted through outreach	Same as Alternative 1	Same as Alternative 1

Environmentally Preferable Alternative

According to Council on Environmental Quality (CEQ) regulations implementing NEPA (43 CFR 46.30), the environmentally preferable alternative is the alternative "that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources. The environmentally preferable alternative is identified on consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources. In some situations, such as when different alternatives impact different resources to different degrees, there may be more than one environmentally preferable alternative."

Alternative 2 (Moderate Intensity Fisheries Management) is the environmentally preferable alternative for several reasons: 1) Alternative 2 would promote active protection and restoration of native fish populations in GCNP. 2) This alternative would also promote protection and enhancement of the highly valued recreational rainbow trout fishery in GCNRA's Glen Canyon Reach. 3) It would also address concerns from Traditionally Associated American Indian Tribes by limiting the number of fish killed and using as many fish as possible for human consumption. This would allow attainment of the widest beneficial uses of the environment, and preserve cultural and natural aspects of our national heritage.

By contrast, Alternative 1 (No Action) is not the environmentally preferable alternative because it would result in inadequate control of non-native fish and prevention thereby jeopardizing the quality of the park's natural and cultural resources and visitor experience.

Alternative 3 (Intensive Fisheries Management) is not the environmentally preferable alternative because although it would employ a more aggressive approach to fisheries management and increase protection and restoration of native fish in GCNP, it would have greater impacts to ethnographic resources and visitor experience. Specifically, this alternative would result in a higher number of fish killed and therefore would not address concerns brought forward by Traditionally Associated American Indian Tribes.

Preferred Alternative

No new information came forward from public scoping or consultation with other agencies to necessitate development of alternatives, other than those described and evaluated in this document. Alternative 2 is the environmentally preferable alternative and better meets project objectives; therefore, it is also considered the Preferred Alternative.

CHAPTER 3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

METHODOLOGY

This chapter describes the Affected Environment (existing setting or baseline conditions) and analyzes potential Environmental Consequences (impacts or effects) that would occur as a result of implementing proposed project. Direct, Indirect, And Cumulative Effects are analyzed for each resource topic carried forward. Potential Impacts are described in terms of Type, Context, Duration, And Intensity. General definitions are as follows, while more specific Impact Thresholds are given for each resource at the beginning of each resource section.

Impact Thresholds **Methodology**

Type describes impact classification as beneficial or adverse, direct or indirect

- **Beneficial** A positive change in resource condition or appearance or a change that moves the resource toward a desired condition
- **Adverse** A change that moves the resource away from a desired condition or detracts from its appearance or condition
- **Direct** An effect caused by an action, that occurs in the same time and place
- **Indirect** An effect caused by an action, but is later in time or farther removed in distance, but still reasonably foreseeable

Context describes the area or location in which the impact would occur. Effects may be site-specific, local, regional, or even broader

Duration describes length of time an effect would occur, short-term or long-term

Intensity describes the degree, level, or strength of an impact. For this analysis, intensity has been categorized into **negligible, minor, moderate, and major**. Because definitions of intensity vary by resource topic, intensity definitions are provided separately for each impact topic analyzed in this EA.

Projects Considered in Cumulative Impact Analysis (CIA) **CIA Projects**

CEQ regulations implementing NEPA require Cumulative Impact Assessment in the decision-making process for federal projects. Cumulative Effects are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative Effects are considered for both No Action and Action Alternatives.

Cumulative Effects are determined by combining impacts of each Alternative with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects in the park units and, if applicable, the surrounding region. Because the scope of this project is relatively large, the geographic and temporal scope of cumulative analysis is similarly broad. Given this, the following projects were identified for conducting the Cumulative Effects Analysis:

Diversions from Roaring Springs for Consumptive Use **CIA Projects**
Since 1967, water has been diverted from Bright Angel Creek at Roaring Springs to North Rim, Phantom Ranch, Indian Garden, and South Rim by way of the trans-canyon pipeline. In 2002, an estimated 1.74

cubic feet per second (CFS) was being diverted (USBR 2002); approximately 5% of Bright Angel Creek's mean annual flow of 35 CFS. An instream flow habitat simulation model run in 1984 indicated an increase in water depletion of up to 30% would have no substantial adverse effects on aquatic insects and fish in the creek (Usher et al. 1984).

Operation of GCD EIS **CIA Projects**

The Operation of GCD Final EIS (USBR 1995) was prepared in response to the 1992 Grand Canyon Protection Act, and analyzed different operation scenarios that met statutory responsibilities for protecting downstream resources and achieving other authorized purposes. The GCD EIS Record of Decision (ROD) (USBR 1996) describes detailed criteria and operating plans for dam operations and includes other management actions to accomplish this objective; among these are the GCD Adaptive Management Program of scientific monitoring and experimentation, beach/habitat-building flows, and further study of temperature control. Modified low fluctuating flows, with minimum flows of 5,000 cfs and maximum flows of 25,000 cfs were instituted in the ROD, with daily stage change restricted to no more than 8,000 cfs.

GCD Adaptive Management Program **CIA Projects**

Initiated through the Operation of GCD FEIS ROD (USBR 1996), this program ensures Grand Canyon Protection Act's primary mandate is met through advances in information and dam management. The GCMRC has primary responsibility for coordinating scientific research and monitoring efforts.

GCNP Tamarisk Management and Tributary Restoration Environmental Assessment **CIA Projects**

Non-native tamarisk (*Tamarix* ssp.) is common riparian tree in GCNP and GCNRA. In 2004, in accordance with its Tamarisk EA (NPS 2002), GCNP began removing tamarisk and other non-native plants along tributaries to restore more natural conditions and prevent degradation of existing native animal and plant life. The tamarisk leaf beetle (*Diorhabda* sp.), a biological control agent, was found in GCNP in 2009. Extensive tamarisk defoliation was observed along the Glen Canyon Reach in June 2012. Substantial mortality will again change structure and function of riparian plant communities.

GCNP Colorado River Management Plan EIS **CIA Projects**

This EIS and subsequent management plan (NPS 2006b) outlines actions to conserve park resources and visitor experience while enhancing river running recreational opportunities on the Colorado River through GCNP. It evaluates a full range of Alternatives including visitor use levels, allocation between commercial and noncommercial sectors, levels of motorized raft use, and visitor use management options. It also evaluates impacts to natural and cultural resources, visitor experience, and Wilderness Character from visitor uses on the Colorado River, and considers and analyzes the social and economic effects of the various Alternatives on the Hualapai Tribe.

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead **CIA Projects**

The ROD (USBR 2007) governs annual water releases from Lake Powell in coordination with Lake Mead operations. This decision identifies mechanisms for addressing discrete levels of shortage volumes associated with Lake Mead elevations relative to Lake Powell reservoir conditions. The decision provides for water deliveries to balance and/or equalize the two reservoirs, in addition to mechanisms to account for conservation, augmentation, and water conservation strategies.

Chute Falls Humpback Chub Translocation **CIA Projects**

This USFWS and GCMRC project (USFWS 2003a, 2004a, 2008) involves capturing juvenile humpback chub from areas downstream of the LCR, and moving the HBC upstream of Chute Falls on the Navajo Nation outside the project area. The purpose of the project is to improve survival and growth of juvenile

humpback chub and expand the species range to areas previously unoccupied by humpback chub (Stone 2006).

GCNP Bright Angel Creek Trout Reduction Project EA **CIA Projects**

This plan (NPS 2006c) directs a multi-year project to reduce the number of non-native brown and rainbow trout in Bright Angel Creek to benefit native fish populations including endangered humpback chub. Native fish uniquely adapted to historic characteristics of the Colorado River and its tributaries have suffered serious declines due to human-caused habitat changes. Bright Angel Creek and its tributaries once supported large numbers of native fish; the native fish assemblage included endangered humpback chub and bonytail (collected in 1942; R. R. Miller, personal communication, August 28, 1944). Today, Bright Angel Creek is the main Grand Canyon spawning site for non-native brown trout—voracious native fish predators. Electro-fishing and weirs were used to capture and remove non-native trout. Removed trout are eaten, smoked for future consumption, or used in other beneficial ways to the extent possible, according to NHPA, Section 106 consultation with Traditionally Associated Indian Tribes.

Development and Implementation of a Protocol for High-Flow Experimental Releases from GCD, Arizona, 2011 through 2020, Colorado River Storage Project **CIA Projects**

This project (USBR 2012a) proposed to develop and implement a protocol for high-flow experiment (HFE) releases from GCD to better determine whether and how sand conservation can be improved in the GCNP Colorado River corridor. This protocol will evaluate short-duration, high-volume dam releases during sediment-enriched conditions for an experimentation period through 2020 to determine whether and how multiple events can be used to better build sandbars and conserve sand over a long period. Sandbars created during high flow events can provide key wildlife habitat, potentially reduce erosion of archeology sites, enhance riparian vegetation, maintain or enhance camping opportunities, and improve Wilderness experience in GCNP.

Non-native Fish Control Downstream from GCD Final EA **CIA Projects**

The mainstem Colorado River and near-shore habitats near the confluence of the Colorado River and the Little Colorado River support the largest aggregation of humpback chub in GCNP. This plan (USBR 2012b) proposed to minimize negative impacts of competition and predation from brown and rainbow trout on endangered humpback chub through control of trout in the area of GCNP's Marble Canyon between the Paria River mouth and Badger Rapid (PBR Reach) (RM 0.9-7.9), and through trout control at the Little Colorado River Inflow. LCR Inflow trout control would be triggered by changes in trout and humpback chub abundance in the LCR reach, among other triggers.

PBR trout control and live removal of rainbow trout were canceled in 2012 following discovery of increased prevalence of whirling disease in the Glen Canyon Reach trout population to avoid spreading disease, and this aspect of the project is being re-evaluated as part of the LTEMP process (see next paragraph). Scientific studies conducted in GCNP suggest trout are a principal competitor and predator of humpback chub, as well as the other native Colorado River fish, in Grand Canyon (see Marsh and Douglas 1997; Ryel and Valdez 1995; Yard et al. 2011, Donner 2011). Trout control activities would be coordinated through GCDAMP.

GCD Long-Term Experimental Management Plan EIS **CIA Projects**

The EIS (USBR, NPS in progress) will fully evaluate dam operations and identify management actions and experimental options that will provide a framework for adaptively managing GCD over the next 15 to 20 years. Relevant to this CFMP EA, resources that will be assessed include hydrology/water delivery, sediment (deposition/erosion), riparian and terrestrial ecology including native, non-native, and endangered species, and aquatic ecology including native, non-native, and endangered species.

GCNP Backcountry Management Plan EIS **CIA Projects**
The park's existing Backcountry Management Plan (NPS 1988) is being updated to comply with current NPS laws and policies and GCNP's 1995 General Management Plan. The new plan provides an opportunity to look at different management strategies for protecting park resources and values while providing for a variety of visitor experiences within the backcountry (Draft EIS expected 2013).

Tusayan Groundwater Developments **CIA Projects**
A development project proposed in Tusayan, Arizona may threaten springs and perennial streams that provide native fish habitat within GCNP by withdrawing water from the same aquifer that is the source for streamflow in Havasu Creek and others.

FISHERIES

Affected Environment

The Colorado River Basin once contained a unique assemblage of 35 native fish species, 74% of which were endemic (Miller 1959). Eight species are native to the project-area (see Appendix A), of which six are endemic to the Colorado River Basin. GCNP historically contained bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*C. latipinnis*, endemic), razorback sucker (*Xyrauchen texanus*, endemic), humpback chub (*Gila cypha*, endemic), bonytail (*G. elegans*, endemic), roundtail chub (*G. robusta*, endemic), Colorado pikeminnow (*Ptychocheilus lucius*, endemic), and speckled dace (*Rhinichthys osculus*). Four of these fish—humpback chub, bonytail, Colorado pikeminnow, razorback sucker—are currently listed as endangered under the ESA, and one—roundtail chub—is considered a candidate for listing in a portion of its range by USFWS. Only humpback chub, flannelmouth sucker, bluehead sucker, and speckled dace have persisted in GCNP (Valdez and Carothers 1998). However, in 2012, razorback sucker was detected for the first time since 1990 by the AZGFD and BioWest, Inc.

Endangered Fish **Fisheries** **Affected Environment**
The following two species, listed as endangered under the ESA, are still present in GCNP.

Humpback Chub (Gila cypha)
The humpback chub was listed as endangered on March 11, 1967 (32 Federal Register [FR] 4001). It is a medium-sized freshwater fish of the minnow family, *Cyprinidae*. Adults have a pronounced hump on their back, a narrow flattened head, large fins, and small eyes. It has silvery sides with a brown or olive-colored back. The HBC is only found in the Colorado River Basin, and GCNP contains the largest population. HBC remains have been dated to at least 4000 B.C., but the fish was not described as a species until the 1940s (Miller 1946) from a specimen collected near Bright Angel Creek in GCNP, presumably because of its restricted distribution in remote whitewater canyons (USFWS 1990). Because of this, its original distribution is not well-known. The HBC is an obligate warm-water species that requires summer water temperatures of about 61-72 °F (16-22°C) for spawning, egg incubation, and optimal survival of young.

HBC attain a maximum size of about 20 inches, can weigh up to three pounds (Valdez and Ryel 1997) and can live 20-30 years (Hendrickson 1993). HBC grow relatively quickly in warm water temperatures until maturity at about four years of age when growth rates slow substantially. Clarkson and Childs (2000) found HBC lengths, weights, and specific growth rates were significantly lower at colder water temperatures, similar to those found in present-day Colorado River below GCD.

HBC typically consume insects, crustaceans, plants, seeds, and occasionally small fish and reptiles (Kaeding and Zimmerman 1983, Kubly 1990, Valdez and Ryel 1995). They appear to be opportunistic

feeders, capable of switching diet according to available food sources, and ingesting food items from the water's surface, mid-water, and river bottom.

There are six HBC populations in the USFWS-defined Colorado River Basin; five in the Upper Basin Recovery Unit (above GCD) (USFWS 2002), and one in the Lower Basin Recovery Unit (see Table 3.1).

Table 3.1 Colorado River Basin HBC Populations

Upper Basin Populations	Location	Status
Colorado River	Cataract Canyon, Utah	Not self-sustaining due to poor reproduction; low levels[a]
	Black Rocks, Colorado	
	Westwater Canyon, Utah	
Green River	Desolation and Grey Canyons, Utah	
Yampa River	Yampa Canyon, Dinosaur National Monument, Colorado	
Lower Basin Populations		
Colorado River	Colorado River and tributaries in GCNP	Largest remaining population in species range, and the only population left in the Lower Basin

[a]USFWS 2011

Upper Basin populations are considered not self-sustaining due to poor reproduction, and most have declined to low levels recently (HBC Five-Year Review, USFWS 2011). The Grand Canyon population is the largest remaining population in this species' range in the Colorado River Basin, and the only population left in the Lower Basin Recovery Unit. The Grand Canyon population consists of nine aggregations with most individuals found within and near the Little Colorado River (Valdez and Ryel 1995; Table 3.2), the largest Colorado River tributary in GCNP. The species spawns primarily in the LCR's lower 13 miles, but occasional spawning is suspected in other areas of the Colorado River (Valdez and Masslich 1999, Andersen et al. 2010).

Mark-recapture methods have been used to assess trends in adult abundance and recruitment of the LCR aggregation using AZGFD-collected data that begins in the late 1980s. Current methods for assessment of GCNP HBC abundance and trend rely on the Age-structured Mark-recapture method (ASMR) (Coggins et al. 2006a, Coggins and Walters 2009). Results of ASMR analyses indicate the adult HBC population declined through the 1980s and early 1990s, but has been increasing for the past decade (Coggins et al. 2006b, Coggins and Walters 2009). The most recent ASMR analysis indicates the Grand Canyon HBC population is 9,000-12,000 (S. Vanderkooi, USGS-GCMRC, personal communication, to B. Healy/NPS, September 28, 2012).

Abundance estimates for HBC aggregations in the mainstem Colorado River outside the LCR were conducted most recently in the mid-1990s (see Table 3.2; Valdez and Ryel 1995). Based on recent preliminary estimates (2012), HBC in several aggregations may have increased as a result of translocations to Shinumo and Havasu Creeks; good LCR production; warmer than normal water temperatures in 2004, 2005, and 2011; and trout control implemented at the LCR Inflow (Persons and Haverbeke, presentation to the Desert Fish Council, November, 2012).

Table 3.2 GCNP Adult HBC Population Estimates

Aggregation	River Mile			Population Estimate	95% Confidence Intervals
30-Mile	29.8	to	31.3	52	24-136
Little Colorado River Inflow*	57	to	65.4	n/a	9,000-12,000
Lava Chuar to Hance	65.7	to	76.3	n/a	
Bright Angel Creek Inflow	83.8	to	92.2	n/a	
Shinumo Creek Inflow	108.1	to	108.6	57	31-149
Stephen Aisle	114.9	to	120.1	n/a	
Middle Granite Gorge	126.1	to	129.0	98	74-153
Havasu Creek Inflow	155.8	to	156.7	13	5-70
Pumpkin Spring	212.5	to	213.2	5	4-16

*LCR estimate for 2011, GCMRC, S. Vanderkooi, personal communication, October 1, 2012
Other populations estimated by Valdez and Ryel, 1995
Population Estimate=where available
n/a=not available

HBC experimental translocations from LCR to Shinumo and Havasu Creeks (see Trammell et al. 2012) were initiated in 2009 and 2011, respectively. Monitoring associated with these translocations has not detected reproduction as of September 2012. However, most fish released into these streams were too young to spawn until 2012. Nevertheless, a large portion of released HBC survived, and growth rates of translocated individuals in Shinumo and Havasu Creeks appear comparable to or greater than growth of LCR juvenile HBC (Spurgeon 2012, Healy 2013, unpublished NPS data, Finch 2012). HBC survival rates in Shinumo Creek increased following declines in rainbow trout abundance and average size following trout control efforts (Palarino and Healy 2013).

Primary range-wide threats to HBC populations include stream-flow regulation, habitat modification (including cold-water releases from dams), competition with and predation by non-native fish species, parasitism, hybridization with other *Gila* species, pesticides, and pollutants (USFWS 2002). In Grand and Marble Canyons, HBC reproduction is hindered by low water temperatures resulting from release of cold water from Lake Powell through GCD (Minckley and Marsh 2009). Predation by rainbow trout and brown trout in the LCR Inflow has been identified as an additional mortality source potentially affecting HBC survival, reproduction, and recruitment (Valdez and Ryel 1995, Marsh and Douglas 1997, Yard et al. 2011). Predation by channel catfish and black bullhead are also thought to threaten the Grand Canyon HBC population, particularly if future waters warm. Adult HBC can reach 20 inches and are unlikely to be preyed on by trout; however, emergent fry, young-of-the-year, and juvenile HBC are susceptible to predation in the LCR and the mainstem. Survival of HBC young in the mainstem is thought to be low because of cold mainstem water temperatures (Clarkson and Childs 2000; Robinson and Childs 2001), and cold water may hinder ability of native fish to escape trout predation (Ward and Bonar 2003). Nevertheless, fish that survive and return to the LCR contribute to the growth (recruitment) of this population. Recent estimates suggest the majority of juvenile HBC recruiting to the population were reared in the Colorado River since 2008 (Pine and Walters, personal communication, to B. Healy/NPS, July 11, 2012).

Despite recent population increases, significant threats to GCNP HBC survival remain, including presence of non-native fish and parasites, altered temperature and flow regimes, and potential for a large-scale disturbance in the main spawning site, the LCR's lower reach. Conservation actions are currently underway by the GCDAMP to help ensure this native fish survives in Grand Canyon, and actions included in CFMP EA Alternatives were also developed to address ongoing threats to HBC.

Razorback Sucker** (Xyrauchen texanus) **Fisheries** **Affected Environment

Razorback sucker was formerly one of the most widely distributed and abundant endemic fish in the Colorado River basin (Minckley and Marsh 2009). The species is now very rare upstream of GCD in the Colorado, Green, and San Juan Rivers. RBS was listed as endangered under the ESA in 1991 (56 FR 54957). The species was brought under hatchery production decades ago to slow or reverse its decline (Minckley and Marsh 2009). Critical habitat, designated in 1994, 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 full pool elevation. A Recovery Plan was approved on December 23, 1998 (USFWS 1998) and recovery goals were approved August 1, 2002 (USFWS 2002b).

The RBS is adapted to widely fluctuating physical environments characteristic of rivers in the pre-Euro-American-settlement Colorado River Basin. RBS grow to three-feet long, and can live 45-50 years and, once reaching maturity between two and seven years of age (Minckley 1983) can produce a large number of young (Bestgen 1990). The ability of RBS to spawn in a variety of habitats, flows, and over a long season are also survival adaptations. In the event of several consecutive years with little or no recruitment, RBS populations demographics might shift, but future reproduction would not be compromised.

RBS persist in both riverine and reservoir/lake habitats, and adults spawn mainly on cobble bars, in rivers and Lake Mead near river inflows (reviewed in Valdez et al. 2012b). Clean gravel or cobble substrates with deep interstitial spaces free of silt are needed for egg deposition to prevent mortality of eggs and larvae (summarized in Valdez et al. 2012b). Ponded floodplain and backwater habitats are important for rearing larvae, as young hatching in flowing waters presumably drift downstream to occupy warm, shallow ponded habitats to feed and grow (Minckley and Marsh 2009). Young RBS feed on plankton, insects, crustaceans and detritus in these floodplain habitats. Rearing habitat may be limited to small backwaters in Lower Colorado River FMZ since large floodplains are absent (Valdez et al. 2012a). The diet of adult RBS consists primarily of aquatic insect larvae, planktonic crustaceans, diatoms, *Cladophora*, and detritus filtered from bottom sediments.

Juvenile RBS as a result of natural spawning have been rare for the last half century, so little is known of their habitats. The greatest threat to continued existence appears to be predation of young by non-native fish. For example, a review of RBS stocking programs in the Lower Colorado River Basin found less than one percent of over 14 million RBS stocked into habitats with non-native fish survived their first year, and that survival increased when larger individuals more capable of avoiding predators were released (Schooley and Marsh 2007). Dams have led to the loss of flooded river bottomlands in spring, a seasonal habitat believed critical for first-year growth and survival. A Lake Mohave population has been created by an augmentation program, and reintroduction programs have released hatchery-raised fish elsewhere, although these programs failed to establish new, persistent populations (Minckley and Marsh 2009).

In the Lower Colorado River Basin, RBS populations exist in Lake Havasu, Lake Mojave, the Salt and Verde Rivers, with a population believed to be self-sustaining in Lake Mead. In addition to reproduction and recruitment documented in Lake Mead through 2011 (Albrecht et al. 2010, Albrecht et al. 2012), recent findings indicate RBS may also be reproducing in or near the San Juan Arm of Lake Powell (Mckinstry 2011). Until recently, RBS had not been reported in Grand Canyon since 1993 (GNCP museum archive data) and only ten other individuals have been reported in Grand Canyon (summarized in Valdez et al. 2012b)

- One adult RBS was reported by an angler from Bright Angel Creek in 1944
- One RBS was captured at the Paria River mouth by the AZGFD in 1963 following GCD closure
- Three RBS adults were captured at the mouth of the Paria River in 1978
- On adult was captured at River Mile 108.3 at Lower Bass Camp in 1984
- One adult female was captured at the Little Colorado River Inflow in 1989

- Three more adults were found in the Little Colorado River Inflow in 1990
- One specimen was collected at Colorado River mile 39.3 by C. O. Minkley in 1993 (GCNP Museum Archive data)

Prior to 2012, RBS were considered extirpated from Grand Canyon. However, during April 2012, five RBS sonic-tagged in Lake Mead were detected upstream of Pearce Ferry Rapid, four of which were detected in GCNP up to Quartermaster Canyon (RM 260) (Kegerries and Albrecht 2012). These fish were all 18 to 22 inches, and were tagged in different areas of Lake Mead in 2010 and 2011. An additional untagged RBS was captured in GCNP on October 7, 2012 during an AZGFD/GCMRC electro-fishing trip near Spencer Creek (RM 246) (A. Bunch, October 7, personal communication, AZGFD). Therefore, as of 2012 razorback sucker are not considered extirpated; however, the extent to which RBS are distributed in GCNP, and their population dynamics, are largely unknown.

Other Native Fish Fisheries Affected Environment

In addition to the two endangered fish species discussed above, three other native fish are found in the project area, and may be effected by proposed actions, including flannelmouth and bluehead sucker, and speckled dace. Habitat immediately below GCD contains limited habitat for native species due to cold-water discharge from the dam. The fish community in this reach is dominated by rainbow trout, a non-native sport fish. Flannelmouth sucker, speckled dace, and occasionally bluehead sucker are found in the Glen Canyon Reach; however, reproduction may not occur (Rogers 2003).

Flannelmouth Sucker (Catostomus latipinnis*) *Fisheries* *Affected Environment

Flannelmouth sucker (FMS), a species endemic to the Colorado River Basin, is found in larger, low elevation warm-water tributaries or mainstem areas of the Colorado River. This species is listed as a species of special concern by USFWS, and is listed as a species of Wildlife of Greatest Conservation Need in Arizona by AZGFD (AZGFD 2006). FMS range-wide distribution is summarized in Utah Department of Natural Resources (2006). In the Lower Basin, the FMS is found below Davis Dam in the Colorado River (reintroduced using Paria River fish), and in Lake Havasu and Lake Mead (Utah DNR 2006), and the Virgin River. In the project area in GCNP and GCNRA, FMS occurs in the mainstem Colorado River throughout Grand Canyon and may occupy sections of the following tributaries for at least part of its life cycle: Paria River, LCR, Bright Angel, Kanab, Shinumo Creeks, and the Havasu Creek Inflow area. GCNRA populations may be sustained through reproduction in GCNP areas where habitat is more suitable (Rogers 2003).

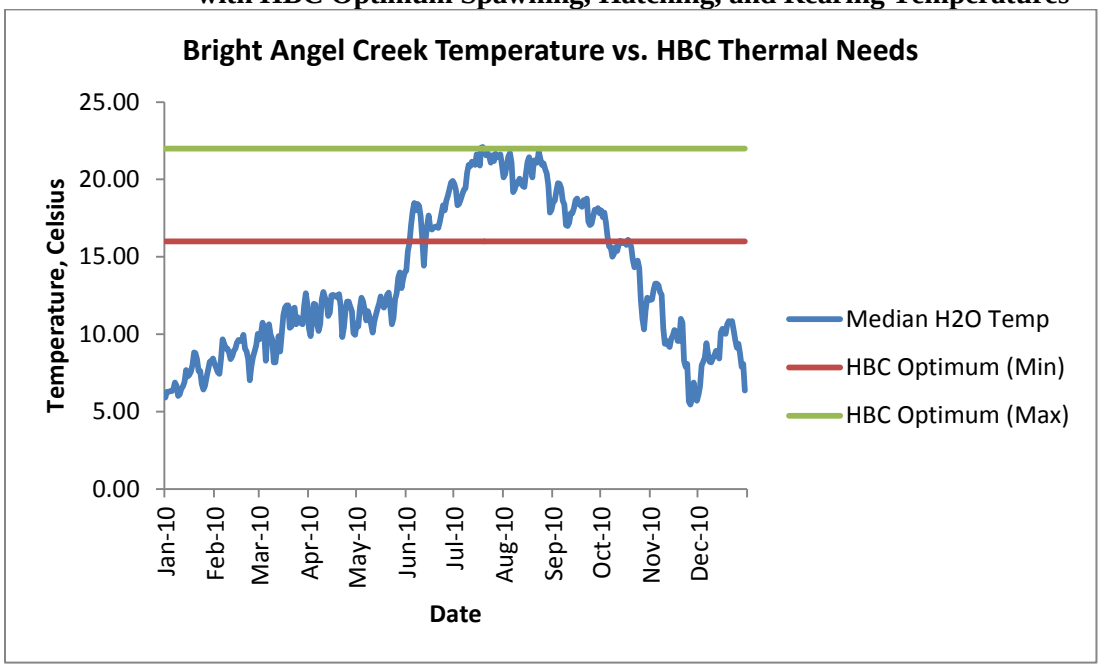
FMS typically mature at four to five years of age (reviewed in Utah DNR 2006) and live to at least 25 years (Mueller and Wydoski 2004). Spawning generally occurs March to June (Robinson et al. 1998) and occurs in the LCR , Paria River, and Bright Angel (Weiss et al. 1998) and Havasu Creeks, and is likely in the mouths of other warm-water tributaries. In the project area, FMS spawning has been observed in tributaries when water temperatures were 48 to 64° F (9 to 18°C, Weiss et al. 1998). Spawning in GCD tailwaters is apparently unsuccessful due to cold water temperatures (Rogers 2003, AZGFD 1996, McKinney et al. 1999), and trout predation on FMS eggs. Following hatching, larval FMS disperse by drifting downstream, entering the colder mainstem Colorado River where survival may be low (Robinson et al. 1998; Valdez and Carothers 1998). Young-of-the-year and juvenile FMS typically inhabit shallow, sheltered shorelines. The FMS feeds on a variety of plant and animal matter (midges, blackflies, *Gammarus*, diatoms, *Cladophora*, seeds, and organic detritus) on the river bottom, and much of GCNP FMS production is attributed to consumption of detritus (debris on the river bottom), and midge and blackfly larvae (Donner 2011). In the LCR, larval FMS consumed mostly midge larvae and organic matter (Childs et al. 1998).

One of the few species to persist in GCNP following dam closure, FMS populations have increased in GCNP in recent years (Bunch et al. 2012, Walters et al. 2012), likely the result of a combination of declining abundance of rainbow trout and warming water temperatures in the mainstem (Walters et al. 2012). While GCNP increases have generally occurred throughout the mainstem, highest numbers are found downstream of Lava Falls (Bunch et al. 2012). However, threats to FMS remain, including predation threat by introduced fish such as channel catfish (Marsh and Douglas 1997), and rainbow and brown trout (Yard et al. 2011, Marsh and Douglas 1997). The ability of FMS to escape trout predation is also inhibited by colder water temperatures (Ward and Bonar 2003). Yard et al. (2011) found numbers of juvenile FMS in trout stomachs at the LCR Inflow that may account for up to 50% of the annual mortality of young suckers (Walters et al. 2012). Adult suckers, which can reach more than 20 inches in length, are less likely to be preyed on by introduced non-native fish currently present in the project area; however, large brown trout have been known to prey upon adult suckers (Yard et al. 2011, Healy and Omana 2011).

Bluehead Sucker (*Catostomus discobulus*) **Fisheries** **Affected Environment**

Bluehead suckers presently occupy about 50% of their former range in the Colorado River Basin (Utah Department of Natural Resources 2006), and are considered a species of Wildlife of Greatest Conservation Need by AZGFD (AZGFD 2006). This large (up to 17 inches), long-lived fish (up to 18 years, Sweet et al. 2009) is widely distributed but may occur in smaller numbers than FMS in GCNP. The species is very rare in the upper sections of GCNP, and increases in number near the LCR Inflow and downstream (Bunch et al. 2012). Bluehead sucker is found in several tributaries in GCNP including the LCR, Bright Angel, Shinumo, Havasu, and Kanab Creeks. Adults use somewhat swifter habitats than FMS, and can navigate upstream through steep cascades in small streams (B. Healy, personal observation). Shallow, near-shore, low-velocity habitats are used by larvae (Childs et al. 1998). Similar to FMS, the bluehead sucker prefers warmer temperatures than those measured in the post-dam Colorado River in GCNRA and GCNP. Spawning occurs primarily mid-March through June in GCNP tributaries, including Shinumo (Allen 1993) and Bright Angel Creeks (Otis 1994) where temperatures are suitable for native fish (see Figure 3.1). Mature fish in spawning condition have also been found in fall in GCNP tributaries (NPS, unpublished data). Once hatched, larval bluehead suckers drift in the current, settling in near-shore areas with less current (Childs et al. 1998). Young consume primarily insects (Childs et al. 1998), and adults are an omnivorous benthic (bottom) feeder, scraping algae, aquatic invertebrates, and other debris (detritus) from rocky substrate (reviewed in Utah Department of Natural Resources 2006). Growth is relatively rapid for juvenile bluehead sucker during their first year of life and is related to water temperature: lower water temperatures reduce growth rates (Robinson and Childs 2000). The species reaches maturity at around two years of age and/or about five inches (127 mm) (Utah Department of Natural Resources 2006).

Figure 3.1 Daily Median Temperatures Recorded in Lower Bright Angel Creek During 2010[a] with HBC Optimum Spawning, Hatching, and Rearing Temperatures[b]



[a]NPS Data
[b]Valdez 2008, representative for native species

The number of bluehead sucker in the Colorado River increased across GCNP since the late 1990s; however, recent analyses suggests declines in abundance have occurred since 2006 (Walters et al. 2012, Van Haverbeke et al. 2011). Nevertheless, high numbers of bluehead sucker remain in Lower Colorado River FMZ (Bunch et al. 2012). In conjunction with NPS HBC translocation and trout control projects in Shinumo, Havasu, and Bright Angel Creeks in Grand Canyon, abundance and survival estimates were calculated for bluehead sucker. Too few bluehead sucker were captured in the Bright Angel Creek lower portion in 2010 to calculate population size for trend analysis (four captured in 0.4 miles [600 m], Omana Smith et al. 2012). Nevertheless, the latest population (2012) estimates for bluehead sucker in Shinumo and Bright Angel Creeks indicate there were 165 fish per 0.6 miles (one km) and 30 per 0.6 miles (one km), respectively (B. Healy/NPS unpublished data), and 1,272/0.6 miles (1,272/km) in the Little Colorado River (VanHaverbeke et al. 2011). Survival rates (percent of adults surviving per year) are slightly lower in the Colorado River for bluehead sucker than for HBC or FMS and the species' life span is shorter as well (Walters et al. 2012). Survival estimates calculated for the isolated bluehead sucker population in Shinumo Creek 2010 to 2012 were higher for larger fish (Healy 2013) and were comparable to those found by Walters et al. (2012) for the rest of Grand Canyon. Limited data are available to assess survival of bluehead suckers in Bright Angel and Havasu Creeks as monitoring programs in those streams were initiated more recently than in Shinumo Creek. Similar to FMS, discussed above, juvenile bluehead suckers are vulnerable to trout predation (Yard et al. 2011). The high abundance of predaceous brown trout in Bright Angel Creek may explain the difference in abundance of bluehead sucker in Shinumo and Bright Angel Creeks. Whiting et al. (2012, 2013) found native fish a dominant food item in brown trout stomachs in Bright Angel Creek.

Speckled Dace **Fisheries** **Affected Environment**
(*Rhinichthys osculus*)
This small (up to four inches), short-lived (two to three years) species is found in the Colorado River and is common to very abundant in perennially flowing tributaries in GCNP. Speckled dace is widespread

throughout the western United States. Preferred habitat is fast moving water over rocky substrate, but the species is found in higher elevation tributaries as well as in the Colorado River. Spawning occurs primarily April-May in tributaries and possibly the mainstem. Diet consists of algae, organic debris, and small macroinvertebrates. The small size of this fish makes it vulnerable to predation even as an adult.

Speckled dace are often found in stomachs of both rainbow and brown trout in tributaries (Spurgeon 2012, Whiting et al. 2012, NPS, unpublished data) and in the mainstem (Yard et al. 2011). In one year of monthly sampling in Bright Angel Creek (May 1976 through June 1977), Minckley (1978) reported speckled dace the most common species captured (population estimate equals 246, or 54% of total). Some evidence suggests a marked decline in speckled dace abundance in the creek since the 1970s as brown trout became established. During trout control efforts in 2012, Nelson et al. (2012) and Heal et al. (2013) noted a large decline in abundance of speckled dace that coincided with an increase in brown trout in Bright Angel Creek, upstream of Phantom Creek.

Extirpated Species

This CFMP EA does not propose management actions to reintroduce extirpated species to the project area; however, reintroduction feasibility studies conducted over the life of the plan would undergo subsequent NEPA analysis.

Colorado Pikeminnow (*Ptychocheilus lucius*) **Fisheries** **Affected Environment**

This endemic member of the Cyprinidae family formerly ranged throughout larger rivers and streams of the Colorado River basin. Formerly common, small reproducing populations persist upstream of Lake Powell. Although commonly observed prior to dam construction (Webb et al. 2002), the species is now extirpated below GCD. Colorado pikeminnow is listed as endangered with designated critical habitat (USFWS 1967, 1994). A recovery plan was developed and revised (USFWS 2002a), and quantitative recovery goals were published by USFWS (2002d).

This species was an important historic resource for Native Americans and early settlers (Minckley and Marsh 2009). Adult fish live in the mainstem of large rivers, mostly over coarse substrates with current in large pools and eddies, and near boulders along edges of riffles and rapids (Minckley and Marsh 2009).This species ranges over large distances, but shows strong fidelity to spawning sites (Irving and Modde 2000). The fish can grow to approximately five feet in length, and is the top native carnivore of the Colorado River system and a voracious predator of fish.

Considerable effort has been expended to reintroduce this species in the Lower Colorado Basin Recovery Unit. Although the species evolved together, concerns exist that this large, piscivorous fish could prey on humpback chub and razorback sucker. Adult and juvenile pikeminnow select temperatures warmer than currently available in much of the project area. An obligate stream spawner, adults migrate long distances to spawning areas, and then larval fish historically drifted downstream long distances to mature and grow.

Roundtail Chub (*Gila robusta*) **Fisheries** **Affected Environment**
Bonytail (*Gila elegans*)

At least one pre-1980 record of roundtail chub, and several pre-1980 records of bonytail exist for the project area (Minckley and Marsh 2009), but no recent occurrences of either species have been recorded; they are considered extirpated from the project area. Bonytail records exist from the mouth of Bright Angel Creek (two individuals collected in June 1944, GCNP Museum Archive data), and from Phantom Creek, a tributary to Bright Angel Creek (one individual collected October 1942; GCNP Museum Archive data). These two chub species are known to hybridize with humpback chub, and therefore reintroductions of these species to GCNP are considered a threat to the genetic purity of humpback chub. No reintroductions of these species are planned or considered in the CFMP EA.

Glen Canyon Rainbow Trout Fishery Fisheries Affected Environment

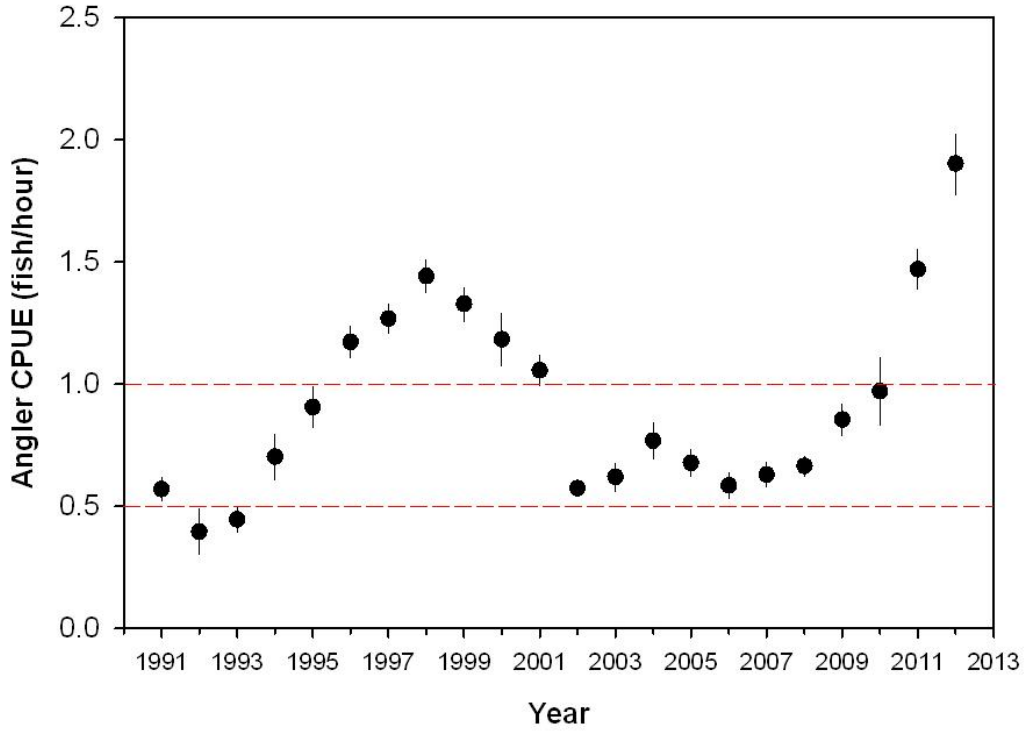
The Glen Canyon Reach was first managed by AZGFD as a sport fishery in 1964, when rainbow trout (*Oncorhyncus mykiss*) were first stocked. The fishery has been extensively monitored as a part of the GDCAMP since 1991, with a standardized monitoring program that evolved over time to reflect recommendations of the GCDAMP or independent external review teams, and budget constraints. Monitoring has allowed evaluation of changes in population metrics including relative abundance (catch-unit-effort), body condition, and size structure of the rainbow trout population in response to dam operations. In addition to monitoring rainbow trout populations, standardized monitoring also provides data on native fish distribution as well as rare non-native fish detection.

Rainbow Trout Fishery Fisheries Affected Environment

Historical Status 1964-1998

Following GCD completion in 1964, extensive stocking of catchable and fingerling rainbow trout occurred in Glen Canyon Reach. From the initial 1964 stocking through the mid-1970s, the majority of rainbow trout stocked were catchable size fish. A shift in management strategy during the mid-1970s lead to stocking fingerling rainbow trout, and managing the fishery as a put-grow-take fishery. During this time, angler catch rates were typically lower; however, average fish size was much larger than currently observed in the fishery. Stocking continued through 1998, untile electro-fishing surveys during that time (1991-1998) indicated the population was steadily increasing in abundance largely due to increases in natural reproduction resulting from a change to the current modified low fluctuating flows. The flows led to a more stable environment favoring reproduction and early rearing. During this period, angler catch rates exhibited trends similar to electro-fishing catch rates, with angler catch per unit effort estimated at 0.56 fish/angler hour in 1991, to 1.44 fish/angler hour in 1998 (Figure 3.2). While increases were observed in both electro-fishing and angling catch rates, a trend of decreasing average fish size was observed during this period; mean length of rainbow trout captured during electro-fishing in 1991 was 30% higher than observed in 1998.

Figure 3.2 Mean Angler Catch Rates (Number of Fish Caught per Hour) of Rainbow Trout in the Glen Canyon Reach Fishery, 1991-2011



Data collected from creel surveys at Lees Ferry boat ramp. Bars represent ±2 standard errors of the mean (close approximation of 95% confidence intervals). Red lines denote 0.5 fish/hour and 1.0 fish/hour catch rates respectively (AZGFD data, M. Anderson, written communication).

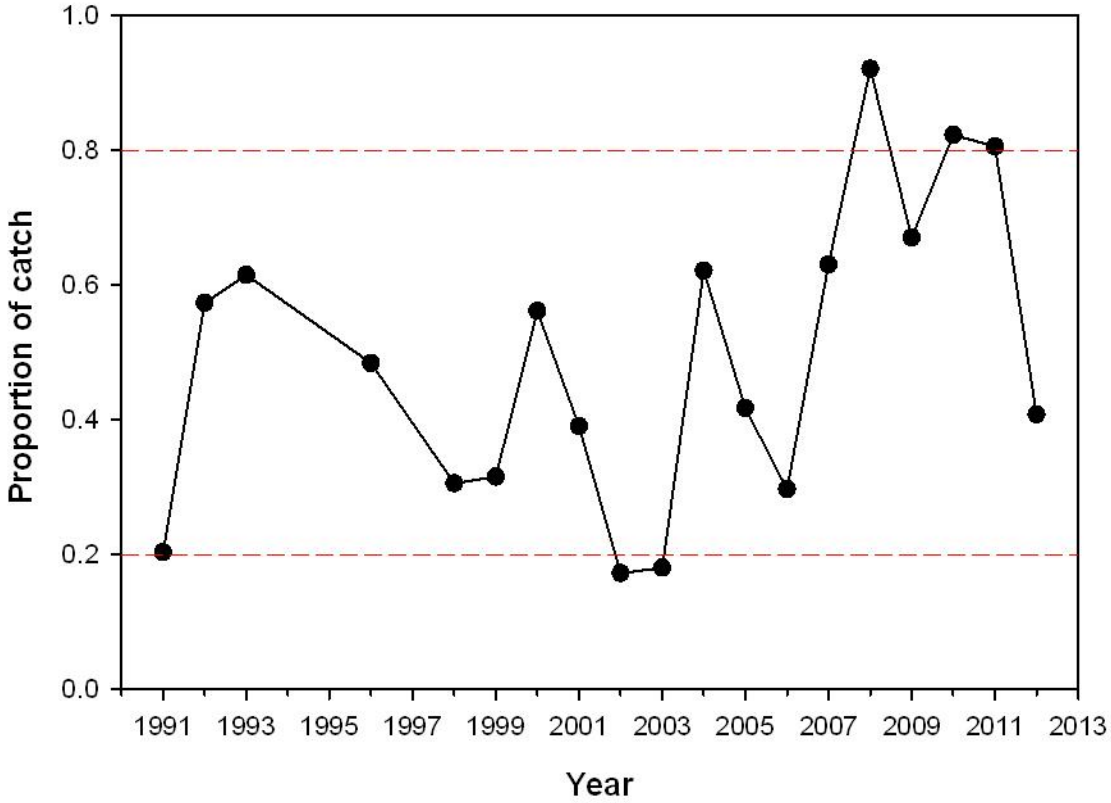
Rainbow Trout Fishery Fisheries Affected Environment

Rainbow Trout Fishery (Current Status 1998-2012)

Following cessation of stocking in 1998, rainbow trout abundance has fluctuated in response to GCD operations. Between 1998 and 2001, relative abundance was relatively stable reflecting the shift to a more stable flow regime. A steady decline in abundance was noted 2002 through 2007 likely due to a combination of factors including dam operations, water quality, and other environmental factors. Following the high flow experiment (HFE) in spring 2008, and subsequent higher steady monthly flows, a significant increase in juvenile rainbow trout abundance was noted likely due to low overall trout abundance in years leading up to the HFE and favorable environmental conditions following the experiment increasing early survival (Korman et al. 2011; Makinster et al. 2010).

Subsequent monitoring (2009-present) has shown this cohort has largely persisted through time and, in combination with Lake Mead equalization flows, led to an abundance of juvenile fish in 2011 five times higher than the mean juvenile abundance observed 1991–2010 (Anderson et al. 2011). Coupled with increased juvenile abundance, there has been a long-term trend of decreasing mean fish length and mean length at maturity Figure 3.3 (AZGFD unpublished data)). During this period, angler catch rates again followed trends similar to electro-fishing catch rates; high catch rates observed 1998-2000 were followed by a sharp decline in 2001 which stayed at relatively low levels through 2007 (Figure 3.3). Angler catch has progressively increased yearly since 2007, with 2011 being the highest catch rates on record for this fishery (1964–2011). Despite high catch rates, only a small percentage (less than 10%) of rainbow trout of harvestable size are harvested in the majority of the Glen Canyon Reach (AZGFD unpublished 2011 data).

Figure 3.3 Proportion of Small Rainbow Trout (less than six inches [150 mm] total length) Captured During Electro-Fishing Surveys, Fall Sampling 1991–2012



Sampling was not conducted in all years. Red lines denote 20% and 80% of overall electro-fishing catch
M. Anderson, AZGFD.

The pathogen that causes whirling disease (*Myxobolus cerebralis*) was detected in Glen Canyon Reach rainbow trout in 2007. Annual testing was negative until 2012 when the disease was found to be more prevalent than in 2007. This pathogen can cause infected fish to swim in an uncontrolled whirling motion and lead to death in rainbow trout. No physical effects or measurable impacts to trout have been noticed. In other states, such as Colorado, in some infected waters most small rainbow trout die three to six months after infection[17].

Non-native Fish Fisheries Affected Environment

Non-native fish species present in Grand Canyon were mostly established as a result of intentional stocking to develop sport fisheries in the Colorado River and its tributaries during the late 1800s and early 1900s. Impacts of these actions was not fully understood until later in the 20th Century when a shift to native species conservation management occurred in the NPS. Negative impacts of non-native fish and altered habitats on native fish species has been well-documented throughout the world. Over 20 non-native fish species have been documented in GCNP; however, the more common, large-bodied, species of management concern include rainbow and brown trout, common carp, channel catfish, and bullhead species (family *Ictaluridae*), striped and smallmouth bass. These species are known predators on native fish or native fish eggs (e.g., common carp) or compete with native fish species. Striped bass and smallmouth bass are relatively uncommon but are captured occasionally in the project area, and large

[17] http://wildlife.state.co.us/Research/Aquatic/WhirlingDisease/Pages/WhirlingDisease.aspx

populations of both species are present upstream in Lake Powell and downstream in Lake Mead. Small-bodied non-native fish such as red shiners or fathead minnow are locally common near the LCR and Colorado River confluence and downstream of Diamond Creek in the Lower Colorado River FMZ. A more complete and detailed review of non-native fish distribution and abundance in GCNP is provided in Hilwig et al. (2009), and in the NPS Biological Assessment for the CFMP (Palarino and Healy 2013). A summary of non-native species information is presented below.

The fish community throughout Marble Canyon, downstream of the Glen Canyon Reach in GCNP, is dominated by non-native rainbow trout. The fish community changes near the LCR Inflow near RM 60 where native species begin to occur. Rainbow trout catch rates have increased over the past several years in Marble Canyon as well (Bunch et al. 2012). The majority of rainbow trout in Marble Canyon originate in GCNRA, and reproduction and downstream movements into Marble Canyon are driven by GCD flow releases (Korman et al. 2012). Rainbow trout in GCNP have a similar diet to endangered humpback chub, and potential for competition between native species and rainbow trout was found to be highest where rainbow trout were most abundant (Donner 2011). Based on analysis of trout diets, rainbow and brown trout have potential to have important impacts on native species through predation in the LCR Inflow and other GCNP areas (Yard et al. 2011). While rainbow trout predation rates on native species were lower than those found for brown trout (Yard et al. 2011, Spurgeon 2012, Whiting et al. 2013), the rainbow trout population as a whole can consume as many or more native fish than brown trout when rainbow trout occur at a much higher abundance, as in the past. A trout removal project was implemented in the LCR Inflow between 2003 and 2006 to reduce effects of trout predation and competition on humpback chub and other native species (Coggins et al. 2011). Trout populations were reduced in this reach through removal efforts, and native species increased in number. However, warmer temperatures during that time made it difficult to fully assess project effectiveness in benefitting native species (Coggins et al. 2011). Nevertheless, Walters et al. (2012) suggested trout control had a beneficial impact on bluehead and flannelmouth sucker because cold temperatures returned as trout numbers remained low, despite continued high sucker recruitment. Since 2008, catch rates of rainbow trout below the LCR Inflow have steadily increased toward pre-trout removal levels through 2011 (Bunch et al. 2012).

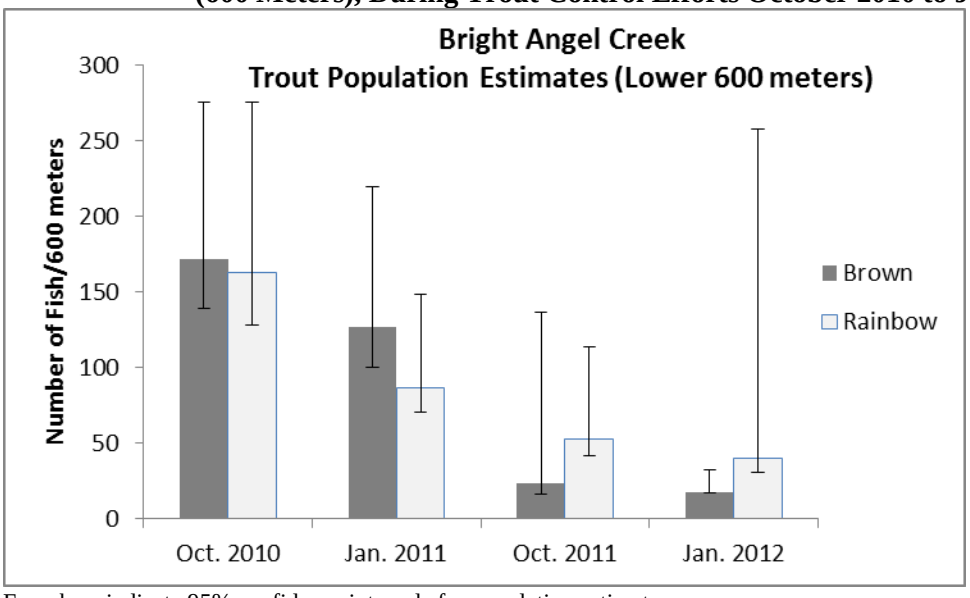
The LCR and LCR Inflow reach, an area critical for native warm-water fish production, is also an area with higher catches of warm-water non-native species such as fathead minnows, plains killifish, channel catfish, and common carp. Stone et al. (2007) demonstrated a mechanism by which non-native fish species and their parasites (Asian tapeworm) residing in perennial sections of river or reservoirs in the upper portions of the LCR watershed greater than 100 miles away could act as a source of non-native fish to critical native fish habitat in the lower LCR.

Downstream of the LCR Inflow, native species decline as non-native brown trout increase in number upstream and downstream of the Bright Angel Creek inflow. The highest densities of brown trout are found in and around Bright Angel Creek, and evidence suggests Bright Angel Creek is the primary spawning area for brown trout in Grand Canyon. Water temperatures fluctuate seasonally in lower Bright Angel Creek (dependent on air temperatures), where the temperature regime is sufficient to support native fish, while headwaters closer to source springs remain consistently cold (NPS unpublished data). Both brown and rainbow trout have been documented on fall/winter spawning migrations into Bright Angel Creek (Omana Smith et al. 2012, Leibfried et al. 2003, Sponholtz et al. 2010). Larger rainbow and brown trout in spawning condition tagged by researchers 30 miles upstream of the LCR (Omana Smith et al. 2012), and from downstream near Lava Falls (great than 80 miles) (Sponholtz et al. 2010) have been recaptured on spawning migrations into Bright Angel Creek. However, most re-captured, tagged fish were originally tagged within several miles of Bright Angel Creek.

Following a 2002-03feasibility study, a trout control project to benefit native species in Bright Angel Creek and endangered humpback chub in the Colorado River was implemented during winters 2006-07,

2010-11, 2011-12, and 2012-13 under a 2006 EA and Finding of No Significant Impact (FONSI, NPS 2006c). Trout control was conducted using a weir to capture spawning trout migrating into Bright Angel Creek and non-lethal electro-fishing equipment to remove trout and monitor trends in native species. After a period of no trout control activities between spring 2007 and fall 2010, removal efforts were focused on lower Bright Angel Creek between the Colorado River and Phantom Creek confluence (approximately 1.8 miles [3000 meters]). In the lowest 0.37 miles (600 meters) where trout control has been consistently applied since 2010, populations of trout were lower as of January 2012 (Figure 3.4), and bluehead sucker have increased from only four individuals (i.e., too few to calculate population estimates) to between 18 and 26 (Omana Smith et al. 2012, Healy et al. 2013). Nevertheless, between fall and winter removal efforts when a high proportion of the population was removed while the weir was in place blocking access to the creek for fish migrating from the Colorado River, populations rebounded somewhat, suggesting the source of fish that re-colonized the reach was upstream where trout control was not applied (Omana Smith et al. 2012). Fall and winter 2012 and 2013 efforts targeted the entire 13 miles of stream for trout control to more effectively meet objectives of the Bright Angel Creek Trout Reduction Project (2006c).

Figure 3.4 Bright Angel Creek Trout Population Estimates for the Creek's Lower 0.37 miles (600 Meters), During Trout Control Efforts October 2010 to January 2012



Error bars indicate 95% confidence intervals for population estimates
Wide error bars for rainbow trout in January 2012 are due to a combination statistical analysis artifact and very few fish captures
Healy et al. 2013

Analysis of rainbow and brown trout seasonal feeding habits captured and removed from Bright Angel Creek during 2010 and 2011 indicated that piscivory (i.e., fish eating) was an important feeding mode for trout, with average piscivory rates on native species of 18% and 5% for brown and rainbow trout, respectively (Whiting et al. 2012). No non-native species were found in trout stomachs, including other trout. Native fish were between less than 1% and almost 20% of the diet of rainbow trout, and between approximately 5% and 48% of the diet of brown trout in November, January, June, and September (D. Whiting, University of Missouri/NPS, unpublished data). In addition to potential predation effects by non-native trout, particularly brown trout, on native fish, there was substantial overlap in diet between trout and native fish, indicating potential for competition between trout and native fish (Whiting et al. 2012).

Rainbow and brown trout are relatively common throughout the mainstem Colorado River in GCNP. Catch rates, however, decline downstream of the LCR and Bright Angel Creek. Both rainbow and brown trout are also found in Tapeats Creek, a continuously cold tributary, and rainbow trout are captured in Havasu, Kanab, and Shinumo Creeks (NPS/SWCA, Inc, unpublished data), among others. A native fish restoration feasibility study conducted for several tributaries within GCNP determined that due to high flow volume and the steep stream bed found in Tapeats Creek, removal of non-native trout efficiently using electro-fishing would be difficult, compared to other streams (SWCA, Inc. unpublished draft report to the NPS). Trout control has been conducted at Shinumo Creek using electro-fishing and angling equipment 2009 through September 2012, in conjunction with humpback chub translocation efforts. As rainbow trout average size and abundance declined 2011 to 2012 as a result of removal of approximately 2,500 trout over three years, survival rate of translocated humpback chub approximately doubled when compared to the previous two years (2011 apparent annual survival rate =0.41, Healy 2013; versus 0.22 and 0.20, for 2009 and 2010, respectively, Spurgeon 2012).

Common carp are common throughout the Colorado River in Grand Canyon, as well as areas of the Glen Canyon Reach . Carp may impact native species by consuming fertilized eggs or through competitive interactions with native fish. Channel catfish are also found in the LCR and its inflow, but are likely more abundant in western sections of GCNP where waters are warmer. Efforts to examine feasibility of removing catfish using angling equipment from areas below Diamond Creek are described in Hilwig et al. (2009), and in summary, efficiency of angling gear for catfish removal is difficult to determine. The generalized fish community in the Lower Colorado River FMZ, between Lava Falls (RM 179.2) and Diamond Creek, has been mainly composed of native species (speckled dace, flannelmouth and bluehead suckers) while downstream areas, particularly below Bridge Canyon (RM 235) were dominated by non-native fish species including common carp, red shiner (*Cyprinella lutrensis*), and others (Hilwig et al. 2009, Valdez et al. 2012b). Non-native fish have been particularly abundant where riverine habitats were transformed into more lake-like habitats, or where the channel was transformed by sediment deposition as a result of Lake Mead formation. Predatory non-native species such as striped bass and channel catfish are commonly captured in this reach as well, and Lake Mead is a potential source for these species to Grand Canyon. Warming waters in GCNP due to low reservoir levels in Lake Powell associated with drought conditions in the upper Colorado River basin, and consequently, warmer GCD discharge may result in increases in abundance of these warm-water predators. Increases in smallmouth bass in the Yampa River in the Upper Basin resulted in accelerated declines in humpback chub there recently (USFWS 2011b).

Environmental Consequences

Baseline information used to assess impacts to native fisheries in GCNP and rainbow trout in the Glen Canyon Reach of GCNRA is described in Chapter 3, Methodology. Fisheries impacts are described in terms of type (beneficial or adverse, direct or indirect), context (site-specific, local, or regional), duration (short-term or long-term), and intensity (negligible, minor, moderate, or major). Beneficial impacts are those that would result in a positive change in resource condition or a change that moves a resource toward its desired condition, while adverse impacts would result in negative changes away from desired condition.

Thresholds

Thresholds of change for intensity of impact on fisheries are defined as:

Negligible Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them extremely unlikely or not noticeable or measurable. If

impacts to individuals occurred, they would be localized, short-term, and of no consequence to the species

Minor Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them affect a small, site-specific portion of the species/range. Short- or long-term disturbances to individuals and/or a small amount of habitat modified. Impacts don't measurably affect migration patterns or other demographic population characteristics (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Mitigation measures to offset adverse impacts to native fish followed

Moderate Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them affect a moderate portion of species/range in the park (i.e., local) or project area but don't affect regional population viability. Short- or long-term impacts result in measurable affects to migration patterns or other demographic characteristics (i.e., age/sex structure, recruitment rates, survival rates, movement population rates, population sizes, population rates of change). Impacts don't significantly increase susceptibility of populations(s) in or near the park to environmental or demographic uncertainty (e.g., severe winters, droughts, disease epidemics, skewed age or sex ratios). Mitigation measures extensive and successful

Major Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them long-term, and affect a large proportion of the species' range in a regional context. Susceptibility of populations(s) in the region to environmental or demographic uncertainty significantly increase. Mitigation measures extensive but success not guaranteed

Duration Short-term impacts would not be detectable for longer than project duration, or at maximum, in the same year. Long-term impacts extend beyond project duration and occur across multiple years

Context Site-specific impacts affect small park areas where the specific action would take place, while local impacts occur across the park, but not beyond park boundaries

Regional impacts extend beyond the project area in the Colorado River Basin

IMPACTS OF ALTERNATIVES

Alternative 1 No Action Environmental Consequences
Impacts To Fisheries

Impacts to fisheries in the project area would likely occur under Alternative 1 in Glen Canyon Reach of GCNRA and in GCNP.

Alternative 1 Direct and Indirect Effects Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery

The geographic scope of the analysis for direct and indirect effects on the rainbow trout fishery in the Glen Canyon Reach includes the Colorado River and riparian areas between GCD and upper Marble Canyon in GCNRA and GCNP.

Outreach efforts to inform visitors of transfer of aquatic nuisance species risk would continue at current levels. Rainbow trout populations in the Glen Canyon Reach would continue to be managed through harvest regulations that may be changed periodically. Rare non-native species such as striped or smallmouth bass would continue to be removed and preserved for research if encountered during ongoing monitoring activities. If large increases in high-risk non-native species of management concern are encountered, emergency removal actions would be implemented in the short term, leading to minor, beneficial, localized, short-term indirect impacts; however, longer-term actions would require additional planning and compliance.

Rainbow trout angler harvest is currently minimal, and would likely continue to be low, resulting in negligible impacts to the rainbow trout population. Thus, continuation of ongoing management actions in Glen Canyon Reach would have negligible direct or indirect impacts to the rainbow trout fishery.

Alternative 1 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fisheries
The geographic scope of Cumulative Effects Analysis includes Glen Canyon Reach as described for direct and indirect effects above and on lands in watersheds outside of GCNP or GCNRA perennially connected to the project area.

Rainbow trout population dynamics would continue to fluctuate, subject to GCD operations, changes in food base (aquatic insects consumed by trout), whirling disease, and other unforeseen changes in conditions. Management responses to impacts of these factors on the rainbow trout fishery to meet fishery goals are limited under Alternative 1, which would lead to minor to moderate, adverse, site-specific, and long-term impacts.

Continued monitoring and research conducted by the AZGFD and GCMRC may result in stress and mortality to individuals captured using electro-fishing. Trout are particularly susceptible to electro-fishing related injuries (Snyder 2003). However, these activities would impact a small number of individuals relative to the large population of rainbow trout, and thus, direct effects would be negligible.

Due to its status as proposed Wilderness, minimal NPS management activities, such as construction projects, would be implemented in the Glen Canyon Reach by GCNRA (subject to NPS MRA). No other changes in NPS management are planned for GCNRA that would impact the rainbow trout fishery.

A previously approved but yet to be implemented trout control project may occur downstream of Glen Canyon Reach in Marble Canyon between in the PBR Reach (Paria Riffle to Badger Rapid, RM 0.9 to RM 8), or in the LCR Inflow reach (USBR 2012b). The PBR Reach removal was cancelled at the time of the CFMP EA development, as explained in Chapter 3, Cumulative Impact Scenarios; however, LCR Inflow trout control may be implemented depending on results of monitoring of trout and humpback chub population dynamics in the LCR Inflow (USBR 2012b). It was predicted that effects of trout control in Marble Canyon would be negligible to rainbow trout fishery upstream in Glen Canyon (USBR 2012b). Long-distance upstream movement of tagged and re-captured trout is relatively rare in Marble or Glen Canyons, suggesting that trout that left Glen Canyon downstream that would be removed would not have returned to Glen Canyon.

Potential for impacts to the rainbow trout fishery exists as a result of future GCD operations as population dynamics are strongly influenced by dam discharge (Korman et al. 2012). Rainbow trout reproduction increased recently following a 2008 high flow experiment flow (with subsequent higher steady flows) and high steady flows in 2011 following high snowpack in the Upper Basin resulting in equalization of reservoir elevations between Lake Powell and Lake Mead. The 194% increase in trout production

following the March 2008 high flow event was due in part to increases in invertebrates palatable to trout (Cross et al. 2011). These large increases in trout production are expected to lead to declining quality of the fishery as flows (and space) decline and competition for limited food increases. As part of recently approved high flow experimental protocol for GCD operation, USBR agreed to pursue several flow options to disadvantage rainbow trout reproduction to minimize risk of impact to endangered humpback chub downstream as a result of experimental high flows (USBR 2011). These actions may also lead to a higher quality trout fishery in Glen Canyon. Lower levels of rainbow trout reproduction may lead to lower densities, less competition for food, and ultimately benefit average size of remaining adult fish, and potentially result in greater maximum sizes. The ongoing LTEMP process led by USBR and NPS will determine dam discharge operations for the next 20 years, and alternatives evaluated may include flow-related options for managing trout populations. Thus, these actions combined with continued monitoring, used to inform future adaptive management of GCD operations, under Alternative 1 may lead to minor, beneficial, localized, and short-term impacts to the rainbow trout fishery.

Alternative 1 Conclusion Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fisheries
In summary, negligible beneficial impacts to the trout fishery that would occur under Alternative 1, and impacts expected from ongoing or future combined state, or federal actions in the Glen Canyon Reach would be minor to moderate, beneficial, localized, short term. If adverse impacts due to whirling disease, dam operations, or other factors were to impact the fishery in the future, limited management responses would be available under Alternative 1, potentially leading to minor to moderate, adverse, localized, long-term impacts.

Alternative 1 Direct and Indirect Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
The geographic scope of analysis for direct and indirect effects includes fish-bearing tributaries and mainstem Colorado River in GCNP and on lands in watersheds outside of GCNP or GCNRA perennially connected to the project area.

Under Alternative 1, no additional recovery actions for humpback chub or other native species would be implemented by NPS in GCNP over the long term without additional NEPA, NHPA, and ESA-related planning and compliance. Thus, native fish communities in GCNP would be expected to decline as non-native fish species return to previous levels in tributaries and at the LCR Inflow, resulting in increased predation rates on native fish. Continuation of some activities, including the monitoring component of past humpback chub translocation projects at Havasu and Shinumo Creeks, one additional humpback chub translocation to Havasu Creek (previously approved, ending after 2013), and monitoring and outreach activities would continue under Alternative 1.

Harvest by anglers of non-native sport fish in GCNP below Navajo Bridge in Marble Canyon (RM 4.2) and upstream of Separation Canyon (RM 239.5) would continue unlimited, while harvest of trout would be limited to six fish in Marble Canyon between the Paria Riffle and Navajo Bridge, unless changes in harvest regulations are enacted. Nevertheless, harvest by anglers is unlikely to be more than a negligible impact on non-native fish populations, and no changes in harvest levels would be anticipated.

As discussed above under Alternative 1 for rainbow trout, there are risks associated with monitoring including potential for stress and mortality of individual fish caused directly by sampling equipment and handling by researchers (e.g., measuring, tagging); however, risk of mortality to native species, including endangered humpback chub, is low under Alternative 1. Continued monitoring of humpback chub and native species at Havasu and Shinumo Creeks would continue using hoop-netting and minnow trapping

techniques, which have an even lower likelihood of injury or mortality than other sampling gear types such as electro-fishing and trammel netting. A more thorough review of potential for injury to individual humpback chub is discussed in the NPS Biological Assessment for the CFMP (Palarino and Healy 2013). In summary, while a small number of individuals may be stressed or injured, mortality risk would be low, and negligible impacts to native species populations would be expected due to continued monitoring activities.

Previously approved Bright Angel Creek weir and trout control operations (NPS 2006c) continued through early March 2013; no additional trout control would be conducted in or near Bright Angel Creek without additional planning and compliance. Electro-fishing of Bright Angel Creek, in its entirety, was recently completed but results will not be known until data analysis is completed later in 2013. However, past efforts indicate a large proportion of trout are removed during electro-fishing operations (Omana Smith et al. 2012), and larger trout are more efficiently captured and removed than smaller individuals in Grand Canyon tributaries (Healy et al. 2013) and in other similar situations (see Saunders et al. 2011).

Larger trout may be more likely to be piscivorous in Grand Canyon tributaries (e.g., Bright Angel Creek, Whiting et al, 2013; Shinumo Creek, Spurgeon 2012), and thus reproduction and recruitment of bluehead sucker and other native fish may be expected to improve during 2013 in Bright Angel Creek, but not in future years. Effect of past and 2012-13 removal efforts on trout size structure and abundance, and native fish recruitment may be temporary without continuation of some mechanical control efforts to maintain low abundance of trout. Increased compensatory survival of young-of-year trout may occur following removal of adult trout, potentially increasing competition for food with native fish. However, while rainbow and brown trout populations have been reduced in the lower portions of Bright Angel Creek (see Figure 3.4, Healy et al. 2013), downstream of Phantom Creek, over the past two winters, a reduction in brown trout had not been detected as of 2011 sampling efforts in the mainstem Colorado River (Bunch et al. 2012). It is likely a longer-term, sustained effort is needed to reduce non-native trout in Bright Angel Creek and the adjacent mainstem reach of the Colorado River.

Similarly, without weir installation beyond late winter 2013, brown and rainbow trout from the mainstem would return to Bright Angel Creek and spawn. Because Bright Angel Creek is the largest source of brown trout to the Colorado River in Grand Canyon, discontinuing weir and removal efforts may result in increased abundance of brown trout at a parkwide (local) scale. Thus, minor, beneficial, site-specific effects to native fish resulting from 2012-13 trout control efforts in Bright Angel Creek may be short term, and over the long term, after control efforts cease, moderate, adverse, local long-term impacts to native species may be expected.

The third of three experimental translocations of humpback chub to Havasu Creek would occur in 2013, and then no future translocations to any Grand Canyon tributaries in GCNP would occur. Similarly, no further trout control would be implemented in those tributaries over the long term. Continued monitoring would allow for future evaluation of the success of those projects in establishing a second spawning population of humpback chub in Grand Canyon, or providing rearing opportunities for juvenile humpback chub to grow larger and then move downstream to augment mainstem aggregations, among other potential expected outcomes. It is likely humpback chub released into both tributaries would grow to adult size at rates comparable to or greater than those in the Colorado or Little Colorado Rivers, and augmentation of Havasu and Shinumo Inflows humpback chub aggregations would continue in short term. It remains uncertain whether translocated fish would successfully reproduce in either of the tributaries or the adjacent mainstem. If reproduction occurred, risk of loss of genetic integrity may occur without future additional translocations. Reduced trout populations achieved over the past three years through removal efforts in sections of Shinumo Creek would not be maintained, and trout size and abundance would likely rebound without some level of control, potentially increasing competition

between rainbow trout and translocated humpback chub and other native fish. Nevertheless, minor, indirect, adverse site-specific impacts associated with Alternative 1 would be expected.

Small numbers of rare, non-native predatory fish such as striped bass and smallmouth bass would continue to be removed if captured during monitoring efforts in GCNP, following protocols established by GCMRC, which would result in negligible impacts to native species. Emergency non-native fish control responses to new invasions of non-native species or increased abundances of existing high-priority species of management concern would be implemented, if needed, over short time scales and in localized areas, and long-term control efforts would continue following additional planning and compliance, if necessary. Emergency control responses would have minor to moderate (depending on threat level), beneficial, local, short-term impacts to native fish communities.

Alternative 1 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
The geographical scope of Cumulative Effects Analysis of Alternative 1 includes all GCNP waters where management activities may impact fish or fish habitat and on lands in watersheds outside GCNP or GCNRA perennially connected to the project area.

Continued monitoring and research conducted by the AZGFD, USFWS, NPS, and GCMRC may result in stress and mortality to individuals captured using electro-fishing equipment, trammel nets, or other types of fish sampling gear. As explained above under Alternative 1 for impacts to fisheries in the Glen Canyon reach, trout are particularly susceptible to electro-fishing related injuries (Snyder 2003), but effects to trout populations and resulting benefits to native species in GCNP would be negligible. A complete analysis of effects of sampling gear on humpback chub was completed in the NPS Biological Assessment for the CFMP (Palarino and Healy 2013). While stress and injuries to individuals may occur, population-level impacts would be unlikely. Monitoring activities conducted by federal and state agencies would be permitted under an ESA permit issued by USFWS, which would include measures to minimize impact to individual humpback chub and other ESA-listed species. These measures would also reduce likelihood of injury to other native fish species as well. Thus, impacts to native species due to ongoing monitoring and research by federal and state agencies, combined with monitoring conducted by the NPS under Alternative 1, would be negligible, site-specific, short term.

The high flow experimental protocol actions approved in the recent USBR EA (2012a) may also impact habitat for humpback chub and other native fish species and result in increased trout production in Glen Canyon Reach, as described for rainbow trout fishery impacts under Alternative 1. However, triggered non-native fish control in Marble Canyon under the USBR non-native fish control EA (USBR 2012b), combined with NPS trout control activities not continued under Alternative 1, were designed to offset these impacts. During 2011, high Upper Basin snowpack resulted in dam discharge maintaining flows above approximately 20,000 cubic-feet/second spring and summer, which resulted in high trout production.

Several actions in Alternatives 2 and 3 of this CFMP EA would not be implemented under Alternative 1, including humpback chub translocations into GCNP tributaries and expanded brown trout control, were also included as humpback chub conservation measures in the latest BO for GCD operation (USFWS 2011a). In addition, to meet legal USBR obligations under ESA for non-native fish control, a large-scale trout control program would be implemented near the LCR Inflow, if triggered by increases in trout numbers and declines in the humpback chub population, among other metrics (USBR 2012b). Up to six non-native fish removal trips would be conducted in the LCR Inflow as well as associated monitoring. Efforts would benefit humpback chub, but intensity of beneficial impact is somewhat uncertain and may depend on electro-fishing removal efficiency rates, extent of emigration from Glen Canyon, and strength

of interactions between humpback chub and rainbow trout, among other uncertainties. Effects of this action were expected to be beneficial to humpback chub when combined with long-term implementation of NPS activities such as Bright Angel Creek trout control and humpback chub translocations (USBR 2012b). However, Alternative 1 would not extend implementation of these NPS activities, and thus, benefits to native fish may be less extensive than intended with implementation of LCR removals by themselves, and result in minor to moderate, adverse, local, short-term impacts to native fish.

As discussed above for Glen Canyon fisheries impacts under Alternative 1, PBR Reach trout control activities are tentatively cancelled, and further trout management or trout control actions are being considered under the LTEMP planning process led by USBR and NPS. Potential effects of various alternatives being considered for implementation under LTEMP are unknown at this time; however, analysis and modeling are in progress.

Translocations of juvenile humpback chub from the lower LCR to areas of the LCR above Chute Falls may continue, providing additional rearing opportunities and range expansion of humpback chub in the LCR; however, population redundancy would not be achieved. Nevertheless, this activity may continue to result in increased growth, and possibly, survival, of several hundred juvenile humpback chub per year.

A development project proposed in Tusayan, Arizona may threaten native fish habitat by withdrawing water from the same aquifer that is the basis for streamflow in Havasu Creek; however, actual water withdrawals and their effects on Havasu Creek baseflow may be less than 5%. These aquatic habitat impacts would be minor, adverse, site-specific (limited to Havasu Creek), but long term.

Alternative 1 Conclusion Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
In summary, actions proposed under Alternative 1 would not continue long-term, and thus, after non-native fish control and humpback chub translocations end, would result in moderate, adverse local, long-term impacts to humpback chub and other native fish. Ongoing high flow events conducted by other agencies, without comprehensive brown trout control and humpback chub translocations, may result in minor to moderate, adverse, long-term, local, impacts to humpback chub and other native fish, even when combined with other trout control efforts implemented by USBR and others. Intensity of impact depends on effectiveness of trout control and unknown future GCD effects.

Alternative 2 Moderate Intensity Fisheries Management Fisheries NPS Preferred

Impacts to fisheries in the project area would likely occur under Alternative 2 in the Glen Canyon Reach and GCNP.

Alternative 2 Direct and Indirect Effects Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery
The geographic scope of analysis for direct and indirect effects on the rainbow trout fishery in Glen Canyon Reach includes the Colorado River and riparian areas between GCD and upper Marble Canyon within GCNRA and GCNP.

Alternative 2 analysis of effects included all activities discussed under Alternative 1 plus removal of additional non-native, predatory species of management concern including brown trout, catfish species, and other rare non-natives (smallmouth bass, striped bass, etc.) captured during monitoring efforts at a

project area scale. Stocking of sterile (triploid) rainbow trout in an adaptive management context in the Glen Canyon Reach is also included in Alternative 2's impacts analysis.

Stocking of sterile rainbow trout could be conducted if triggered by low angler catch rates, low catch rates detected during AZGFD electro-fishing monitoring, or low natural reproduction and recruitment for consecutive years. Since 1991, conditions approached, but never met, thresholds to initiate stocking of sterile trout proposed under this EA. In the early 2000s, the proportion of fish smaller than six inches met thresholds, but angler catch rates remained above 0.5 fish/per hour. However, changing conditions related to water quality, disease, GCD discharge, and other factors may lead to future low recruitment and low catch rates. Stocking of sterile trout may offset losses that occur, benefitting the fishery over the long-term; however, the outcome of sterile trout in regard to angler catch rates and average size of fish caught is uncertain. Whirling disease was found to be more prevalent recently than in the past, and disease effects somewhat unpredictable. Once whirling disease is found in a water body, there is no known method to remove it. Sterile trout would be stocked at a size not sensitive to whirling disease. While sterile rainbow trout performance varies compared to wild fertile fish (Anderson 2012), the adaptive approach, including monitoring of marked stocked trout (to differentiate between hatchery-produced and wild trout) would allow stocking plan changes to help ensure long-term program success. Some studies suggest growth rates in sterile hatchery fish may exceed diploid (fertile), but others found the opposite (Anderson 2012). Sterile trout have not been released into the Glen Canyon Reach in the past, and thus, intensity of beneficial effect to the rainbow trout fishery would be minor to moderate, depending on stocked trout performance. Impacts of sterile trout stocking would be minor to moderate, beneficial, local, and short to long term.

The Bright Angel Creek weir and trout control operations throughout Bright Angel Creek ended in March 2013. Under Alternative 2, comprehensive trout control around Bright Angel Creek would be continued and expanded from previous efforts to the Bright Angel Creek Inflow of the Colorado River. This activity would have no impact on the rainbow trout fishery in the Glen Canyon Reach because the majority of trout in the Glen Canyon Reach are produced locally (Korman et al. 2012). In addition, there has been no documented link between rainbow trout populations in Glen Canyon and those produced in Bright Angel Creek (no movement between populations) likely due to large distances between them (greater than 85 river miles). The number of rainbow trout removed during Bright Angel Creek trout control operations is small relative to the large rainbow trout population in Glen Canyon (hundreds versus hundreds of thousands).

Similar to Bright Angel Creek trout control, other actions proposed under Alternative 2 designed to benefit native fish species implemented in GCNP would have negligible impacts on the Glen Canyon rainbow trout fishery.

Alternative 2 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery
The geographic scope of the Cumulative Effects Analysis includes the Glen Canyon Reach as described for direct and indirect effects above, as well as activities occurring on lands in watersheds outside GCNP or GCNRA connected to the project area.

Alternative 2 Cumulative Effects on Glen Canyon rainbow trout are similar to Alternative 1, except sterile trout stocking would be included. This additional activity would allow an insurance mechanism to maintain the trout fishery through hatchery production in the case trout recruitment and angler catch rates were severely limited due to future GCD operations, including flows designed to disadvantage trout reproduction, whirling disease, or other environmental factors. In summary, impacts to the trout fishery would be minor to moderate, beneficial, local, and short to long term.

Alternative 2 Conclusion Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery
Depending on extent of fishery decline, if any, and assuming other factors such as food base or water quality deterioration did not preclude survival and growth of stocked fish, Alternative 2 effects on the Glen Canyon rainbow trout fishery would be minor to moderate, beneficial, local, and short to long term. Sterile trout have not been released into the Glen Canyon Reach in the past, and thus, intensity and duration of beneficial effect to the rainbow trout fishery would be minor to moderate (depending on stocked trout performance) beneficial, local, and short to long term.

Alternative 2 Direct and Indirect Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
The geographic scope of analysis for Alternative 2direct and indirect effects includes the fish-bearing tributaries and mainstem Colorado River within GCNP.

Several proposed activities involve humpback chub conservation measure implementation listed in the most recent Biological Opinion for GCD operations. These include humpback chub translocations and associated non-native fish control, Bright Angel Creek comprehensive brown trout control, and actions to conserve and monitor mainstem humpback chub aggregations (USFWS 2011a). Nevertheless, aspects of these conservation measures and other actions designed to benefit native species, including HBC, may have potential to cause injury or mortality to individuals in both the mainstem and Grand Canyon tributaries during capture using electro-fishing gear and netting and during handling of fish during trout removal and monitoring operations. Analysis focuses on actions to conserve and recover humpback chub and native fish species and those actions that may harm individuals.

As discussed for Alternative 1, although the CFMP was developed to conserve native fish communities in GCNP, there are risks associated with some activities related to handling-stress and mortality caused directly by fish sampling equipment and handling by researchers (measuring, tagging). Risk of injury and mortality to individual native fish is higher in Alternative 2 compared to Alternative 1 due to increased non-native fish control at Bright Angel and Shinumo Creeks, and volunteer trout angling removal trips in Marble Canyon. Monitoring of HBC associated with translocation projects, as well as collection of juvenile HBC from the LCR also has potential to harm or cause mortality of individuals.

A review of past capture and handling data help inform assessment of risk of injury to HBC for proposed actions. No immediate mortality of translocated fish was observed in Shinumo and Havasu Creeks after capturing and handling HBC on over 1,100 occasions since 2009, including fish handled on multiple occasions during the same monitoring trip (NPS, unpublished data). Fish were mainly captured in hoop nets, minnow traps, and seining, with a small number captured with angling and electro-fishing equipment. Mainstem HBC aggregation monitoring has been conducted using both hoop and trammel nets. A higher level of risk to native fish species may be expected from trammel netting, and immediate mortality has been observed, but steps would be taken to minimize risk (see Chapter 2, Best Management Practices), and most monitoring associated with translocations would use other gear types (i.e., hoop nets).

In contrast, delayed mortality cannot be observed in the field during monitoring efforts because fish are released immediately, and thus, delayed mortality may have occurred and gone unnoticed following release of fish. However, monitoring of HBC collected for translocations that occurred while they were held in hatcheries over winter 2008-2012 indicated post-capture mortality of fish collected was generally

less than 5%, with the highest mortality during one year approaching 10%, when most mortality occurred during standard disease treatments in the hatchery.
Handling of HBC during collection and hatchery rearing, including standard disease treatments, is much more intense than handling HBC and other native fish during field monitoring or non-native fish control, and thus injury and mortality would be assumed to be lower in the field.

Electro-fishing would be used widely for non-native fish control in GCNP, including in conjunction with HBC translocation projects. The effects of electro-fishing on fish were extensively reviewed by Snyder (2003) who concluded, except in extreme cases, injuries due to electro-fishing heal and result in minimal delayed mortality, and even in salmonids, which are particularly sensitive to injury by electro-fishing, population-level effects would be unlikely. Nevertheless, best management practices were developed to minimize stress on fish during proposed activities. Adverse impacts related to handling due to electro-fishing and other monitoring efforts would therefore be negligible. A more complete discussion is included in the NPS Biological Assessment for the CFMP (Palarino and Healy 2013).

Between 500 to several thousand juvenile HBC may be collected from the LCR per year to support proposed translocation efforts over the life of the plan. The smallest size classes that can be effectively captured and maintained in a hatchery successfully would be targeted for translocation collections to minimize risk of impacts to the adult population of HBC in the LCR. No extinction risk and a negligible change in the LCR HBC population was found during analysis of proposed collections efforts, combined with collections to support scientific activities (Pine et al. *in press*). Between 50 and 200 (up to 1,000) HBC were estimated lost due to handling stress and collections for scientific purposes in the past (P. Sponholtz, USFWS, personal communication, as cited in USFWS 2011a). This pattern of incidental loss of individual loss of humpback chub is what would be expected in the future, and between 500 and 800 juvenile HBC have been collected annually from the LCR since 2008 for translocations and refuge development. Despite these losses, the LCR HBC population has not declined, but instead, appears to be on a continuing upward trend, indicating the level of handling and removals for translocations and other purposes would not have more than minor, adverse, site-specific, short-term, impacts on the population as a whole.

Proposed activities were designed to achieve NPS conservation goals, desired conditions, and objectives for native fish communities and contribute toward HBC recovery over the long term (20 years or more). CFMP Goals and Objectives for humpback chub emphasize restoring a broader HBC distribution throughout GCNP, and augmenting or expanding existing aggregations while reducing potential for predation by, and competition with non-native species. Monitoring and the proposed adaptive management strategy would help ensure these goals are met.

Comprehensive mechanical removal of brown and rainbow trout in Bright Angel Creek and the Inflow area using tributary electro-fishing, boat-based electro-fishing in the Inflow, and weir installation and operation during fall/ winter months may benefit HBC and native fish species' populations in several ways. Low survival of juvenile HBC likely led to past declining trends in adult HBC (Coggins et al. 2006b), and brown and rainbow trout predation can be an important source of mortality for juvenile HBC, particularly when trout are in high abundance (Yard et al. 2011, USFWS 2011a) and water temperatures are cold. At warmer water temperatures, other species may constitute a greater threat (e.g., smallmouth bass). Data suggest Bright Angel Creek is an important source of brown trout for Grand Canyon, and therefore the most intensive brown trout control efforts would be focused in Bright Angel Creek and between Zoroaster and Horn Creek rapids on the Colorado River upstream and downstream of the mouth of Bright Angel Creek. By removing brown trout at their source, emigration to the LCR Inflow, and thus predation, would be likely minimized (USFWS 2011a).

Dispersal of juvenile native fish from the LCR to downstream aggregations where temperatures are warmer may be enhanced by reducing the number of trout in the Bright Angel Inflow as well. Boat electro-fishing in the Inflow of Bright Angel Creek would be implemented when adult trout are aggregating in the reach prior to spawning migrations into the creek. This would also be the time when turbidity (water clouded by suspended sediment) would be less likely to inhibit capture efficiency (USGS-GCMRC turbidity data, summarized by C. Nelson, NPS). Finally, fish from the previous years' cohort will have grown to a size that would allow them to be captured more efficiently using electro-fishing equipment in fall (smaller fish are less likely to be captured relative to larger fish, Healy et al. 2013, Saunders et al. 2011). Depending on effectiveness of Alternative 2's proposed trout control program, native bluehead suckers and speckled dace populations are expected to increase as brown and rainbow trout populations are reduced in Bright Angel Creek and the adjacent Colorado River. Monitoring results and the adaptive management framework would allow for future adaptation of mechanical removal methods (increase or decrease effort), to ensure success; however, some methodology changes may require additional planning and compliance. Comprehensive trout control in Bright Angel Creek and adjacent areas would therefore have a moderate, beneficial, local, and long-term impact on native fish in GCNP.

Brown trout and other highly piscivorous species (Ictalurids/catfish, striped bass, smallmouth bass, etc.) incidentally captured from anywhere in the project area during monitoring efforts would also be removed. Although the extent to which this action may contribute toward a population-scale decline of brown trout or other species is difficult to predict, microchemistry analysis of fish head bones (see Hayden et al. 2012) could be performed identifying their natal origin (if funding is available). Identifying other sources, beyond Bright Angel Creek, of these predators may help focus future control efforts and improve efficiency of non-native fish control programs.

Havasu and Shinumo Creeks would be the focus of initial HBC translocations, while adhering to genetic management principles to minimize potential for loss of genetic integrity in small translocated populations. Depending on results of trout control efforts at Bright Angel Creek, following a five-year evaluation, HBC may also be translocated there as well. Ideally, depending on availability of fish from the source population (LCR) and hatchery space, 200 additional HBC would be translocated to both Shinumo and Havasu Creeks for a minimum of five years, up to ten years, followed by population and genetic monitoring and augmentation (additional translocations), if necessary. After a review of habitat characteristics and existing fish communities, these tributaries were thought to be the highest priorities for translocations (Valdez et al. 2000; GCWC 2006). Bright Angel Creek was initially dismissed from consideration due to high numbers of brown and rainbow trout (Valdez et al. 2000).

Other tributaries or mainstem areas would continue to be assessed, and in the future, following interagency discussions, may be considered for translocations. HBC translocations may eventually contribute toward establishment of a second spawning population in GCNP (HBC Outcome 1); however, whether HBC will spawn in a tributary outside the LCR or in a mainstem area is a key uncertainty that will be determined through additional monitoring. Based on growth rates of HBC translocated to Shinumo Creek (Spurgeon 2012, Healy 2013), and Havasu Creek (Healy 2013), and since lower Bright Angel Creek has a similar annual temperature range compared to Shinumo Creek (Voichick and Wright 2007), it is likely translocations would, at the least, provide suitable rearing opportunities for juvenile HBC in these tributaries. Translocated HBC would continue to contribute toward augmentation of mainstem aggregations (HBC Outcome 2). Revised and expanded mainstem monitoring and continued maintenance of the Shinumo Creek PIT-tag antenna may allow for improved precision of estimation of movement rates, survival, and population estimates. Duration and intensity of the beneficial, local effect of HBC (or other native fish) translocations in GCNP would depend on whether HBC reproduce and develop a second viable spawning aggregation (long-term, moderate effect), or translocation projects

function as mechanisms to provide suitable rearing opportunities (short-term, minor effect). Thus translocations would have a minor to moderate, beneficial, local, short- to long-term impact on HBC.

Expanded annual electro-fishing in lower sections of Shinumo Creek (where HBC are released), which would occur no more than once per year, would allow for improved monitoring of rainbow trout population trends, and higher efficiency trout removal. Trout removal using angling equipment would also be conducted on monitoring trips when electro-fishing gear would not be used (June). As discussed above, HBC survival doubled from previous years when trout abundance was at its lowest, and continued trout control would be expected to benefit translocated HBC survival and growth (rearing potential) and resident native species (e.g., bluehead sucker) through decreased predation and competition. Duration of beneficial effect would depend on duration of trout control under Alternative 2, and effects would be expected to be minor, beneficial, site-specific, short to long term (depending on action duration).

Under Alternative 2, razorback sucker status surveys included in the first phase of the proposed feasibility study, includes a larval fish study to determine whether the species is present and whether spawning may be occurring in Lower Colorado River FMZ between Lava Falls (RM 179.2) and the Lake Mead Inflow. Over the study's three-year duration, these activities may result in death of individual larval HBC, flannelmouth and bluehead suckers, speckled dace, and razorback sucker if spawning is occurring in this area. Lethal sampling is required since larval fish identification must be performed in a laboratory. However, the number of larval HBC or other native larval fish collected would represent a small fraction of larval fish in the Lower Colorado River FMZ where native fish abundance is high, and thus, effect would be negligible. In addition, if larval HBC are collected, analysis can be conducted to determine the individual's natal origin, which would help inform future management by the NPS, USFWS, AZGFD, and GCDAMP. This study would also be evaluated by USFWS during permitting procedures (ESA Section 10). If earlier phases of razorback sucker management/augmentation studies suggest razorback sucker stocking in the Lower Colorado River FMZ is a feasible option to augment population and contribute toward recovery, additional ESA Section 7 consultation, and other planning and compliance processes (i.e., NHPA, NEPA) on effects to HBC may be required. Release of 10-20 sonic-tagged adult razorback sucker in this area, associated with Phase I of the feasibility study, would have negligible impacts to HBC or other native species in the Lower Colorado River FMZ, but could benefit razorback sucker in the future by improving the knowledge base of managers.

Additional monitoring conducted in lower sections of GCNP upstream of Lake Mead for razorback sucker—and other potential sources of non-native species from outside the park (Kanab Creek, Havasu Creek)—associated with Alternative 2 would also minimize risk of new or expanded populations of non-native species to GCNP. Increased coordination with landowners, tribes, and other agencies to improve inventory of potential sources of non-native species to the project area would also provide benefits to native species. Monitoring would allow for early detection of changes, and early removal responses to invasions would more likely be successful, compared to later stages when non-native species have become established and widespread. Nevertheless, pro-active control of existing species such as channel catfish, an action not included in Alternative 2, would likely be more effective than waiting until habitat conditions change due to variation caused by GCD or climate, and the species expands its distribution or abundance increases.

Triploid (sterile) rainbow trout would be released into the Glen Canyon Reach to maintain a sport fishery in the event that rainbow trout abundance severely declines due to whirling disease, conditions caused by dam operations, or some other unforeseen factor. While non-native species such as rainbow trout prey on and compete with HBC, it is unlikely a negative impact to HBC or other native fish downstream of Glen Canyon would be expected from this proposed action. Stocked sterile trout could not reproduce, and stocking would occur only with extremely low levels of rainbow trout. Nevertheless, rainbow trout pose an important threat to HBC when they occur in the same habitats and in high abundance. In addition,

annual survival and dispersal of hatchery-reared and stocked triploid trout has been shown to be relatively low in some studies (High and Meyer 2009) and thus, stocked fish would likely persist for only short periods and remain in close proximity to their release point. To help ensure potential interactions are minimized between stocked triploid trout in Glen Canyon and native fish in GCNP, each fish released would be marked so ongoing monitoring programs could detect triploid trout movements and performance. Thus, if monitoring indicated stocked triploid rainbow trout were moving downstream into Marble Canyon, or were found at the LCR Inflow, stocking could be adjusted or discontinued. There is potential for some impact through predation on native species if movement downstream of sterile trout occurred, but measureable impacts to native fish populations would be unlikely because trout abundance would be much lower than current levels and thus impacts to native fish would be minor, adverse, site-specific, short term.

Alternative 2 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
The geographical scope for of Alternative 2 Cumulative Effects Analysis is the same as Alternative 1.

Alternative 2's Cumulative Effects to native fish in GCNP would be similar to those described under Alternative 1. However, actions such as non-native trout control in and near Bright Angel Creek and HBC translocations, when combined with non-native fish control in Marble Canyon near the LCR Inflow approved under the USBR Non-native fish control EA (USBR 2012b) would lead to minor to moderate, beneficial, local (parkwide), long-term impacts to HBC and other native fish in GCNP.

While an increase in potential for injury or mortality to individual native fish would occur under Alternative 2, the magnitude of effects would be limited to site-specific park areas where monitoring and mechanical non-native fish removal efforts are focused. Additionally, all monitoring protocols include measures to minimize injuries to fish, therefore benefits to native fish populations from actions included under Alternative 2 would outweigh potential negative effects to individuals as a result of combined NPS, GCMRC, AZGFD, or USFWS monitoring and research activities that involve electro-fishing or netting operations.

As approved under the USBR's non-native fish control EA (USBR 2012b), up to six electro-fishing non-native fish removal trips would be conducted in the LCR Inflow if HBC and rainbow trout population triggers are met, in addition to associated monitoring trips conducted in the area. This control effort was predicted to reduce predation on HBC 41 to 70% (average electro-fishing trout capture efficiency, USBR 2012b). Beneficial effect magnitude to HBC may depend on electro-fishing removal efficiency rates, extent of emigration from Glen Canyon, and strength of interactions between HBC and rainbow trout, among other uncertainties. Effects of this action were expected to be beneficial to HBC and razorback sucker when combined with long-term implementation of NPS activities proposed under Alternative 2 such as Bright Angel Creek trout control and humpback chub translocations (USBR 2012b). The majority of brown trout found in the LCR Inflow are likely produced in Bright Angel Creek, so implementation of trout removal in Bright Angel Creek and Inflow, combined with triggered non-native trout control at the LCR would result in a moderate, beneficial, local, long-term indirect effects to native fish species.

High flow experimental protocol actions approved in the recent USBR EA (2012a) also may impact habitat for HBC and other native fish species and result in increased trout production in the Glen Canyon Reach. Increases in trout production may lead to additional downstream emigration of rainbow trout into Marble Canyon, potentially increasing negative interactions (competition and predation) between HBC and rainbow trout (Korman et al. 2012). However, triggered non-native fish control in Marble Canyon under the USBR non-native fish control EA (USBR 2012b), combined with NPS trout control activities implemented under Alternative 2 would minimize potential negative impacts. Translocations of HBC and

other native fish, combined with tributary trout control under Alternative 2 would also benefit HBC and native fish. These actions would benefit native fish by providing additional rearing opportunities that may be less than adequate in the Colorado River near the LCR Inflow, if waters discharged from GCD are cold (i.e., less than 10 °C/50 °F discharged or less than 12°C/54 °F at the LCR) in some years. Twelve degrees Celsius (54 °F) is the minimum for HBC growth, and summer temperatures in all three tributaries proposed initially for translocations exceed 16 degrees Celsius (61 °F, minimum of the optimum range for HBC) for over 100 days.

As discussed above, PBR Reach trout control activities are tentatively cancelled, and further trout management or trout control actions are being considered under the LTEMP planning process led by the USBR and NPS. Potential effects of various Alternatives being considered under LTEMP are unknown at this time; however, analysis and modeling are in progress.

Future GCD discharge options that may modify Colorado River temperatures may be evaluated as part of the LTEMP planning process. Warmer temperatures could be achieved through low summer flows, which would provide warmer water to enhance HBC spawning, rearing, and survival in the mainstem Colorado River. Although mainstem rearing and survival of juvenile HBC was demonstrated 2009 to 2012 (Finch 2012), warming waters under fluctuating flows discharged by the GCD may improve HBC growth. However, increased abundance of warm-water non-native fish that have decimated native fish communities in the upper Colorado River Basin remains a concern under warming conditions, which may occur regardless of dam discharge during drought. Responding to increases in abundance or new introductions of warm-water non-native predatory species may become particularly important in the future with increasing Upper Basin drought conditions, low Lake Powell water levels, and consequently, warmer GCD discharge. Alternative 2 CFMP would allow for mechanical removal responses to these increases in warm-water non-natives, which may reduce risk of impacts to native warm-water fish communities. Thus, emergency non-native fish control responses would have minor to moderate (depending on the threat level), beneficial, local, short-term impacts to native fish communities.

Cumulative Effects of Alternative 2 combined with Chute Falls HBC translocations and Tusayan water withdrawals would not differ for Alternative 2.

Alternative 2 Conclusion Environmental Consequences

Impacts to Fisheries

Grand Canyon Native Fish Community

Translocations would have minor to moderate, beneficial, local, short- to long-term impacts to HBC by achieving a wider distribution and higher abundance of HBC in downstream aggregations, potentially leading to a second spawning aggregation in GCNP. While non-native rainbow trout populations in Glen Canyon may continue to fluctuate depending on dam discharge, whirling disease and other factors, triploid sterile rainbow trout stocking would have minor, short-term,site-specific impacts to native fish. Comprehensive control of brown and rainbow trout around Bright Angel Creek, combined with non-native fish control efforts approved by USBR (2012) would result in indirect, moderate, beneficial, local, long-term impacts to HBC and native fish. Emergency non-native fish control actions would allow managers to react quickly to emerging threats, which may become particularly important with warmer GCD discharge. However, reactive rather than pro-active control of newly invading or expanded populations of warm-water non-native predators may be less effective. Overall, Alternative 2 would have minor to moderate, beneficial, local, long-term impacts on native fish communities in GCNP.

Alternative 3 Intensive Fisheries Management Environmental Consequences
Impacts to Fisheries
Direct and Indirect Effects
Glen Canyon Rainbow Trout Fishery
Direct and indirect effects of actions proposed under Alternative 3 are similar to Alternative 2. The only difference in actions proposed under the two Alternatives would be the removal of common carp captured during monitoring efforts; however, this would not lead to any measureable impact to the rainbow trout fishery in Glen Canyon. Common carp are found in the reach around a warmwater spring and a slough-like backwater area, in extremely low numbers, relative to the large rainbow trout population.

Alternative 3 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery
Cumulative Effects of Alternative 3 on the rainbow trout fishery in Glen Canyon are the same as those described for Alternative 2, since no additional measureable direct or indirect effects would be expected.

Alternative 3 Conclusion Environmental Consequences
Impacts to Fisheries
Glen Canyon Rainbow Trout Fishery
Similar to Alternative 2, Alternative 3effects would depend on extent of fishery decline, if any, assuming other factors such as food base or water quality deterioration did not preclude survival and growth of stocked fish. Therefore, effects of Alternative 3 on the Glen Canyon rainbow trout fishery would be minor to moderate, beneficial, local, and short to long term. Sterile trout have not been released into the Glen Canyon Reach in the past, and thus, intensity of beneficial effect to the rainbow trout fishery would be minor to moderate, depending on stocked trout performance.

Alternative 3 Direct and Indirect Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
The geographic scope of analysis for direct and indirect effects under Alternative 3 includes the fish-bearing tributaries and mainstem Colorado River within GCNP.

Alternative 3's proposed fisheries management actions are similar to Alternative 2 with some additional projects and increased extent and frequency of trout control actions at Shinumo and Bright Angel Creeks. The discussion below focuses on differences in projects and their direct and indirect effects between Alternatives 2 and 3.

Under Alternative 2, across the project area, brown trout, bass, catfish, sunfish, and rare non-native predatory fish would be removed if captured during monitoring or research efforts. In addition, under Alternative 3, common carp would also be removed. Common carp are known to consume native fish eggs, and are a concern for endangered fish in the Colorado River basin (L. Fitzpatrick, personal communication, USFWS, September 19, 2012). The population-scale effect on non-native species and potential benefits to native species related to removal of individuals is difficult to predict, but negligible to minor, beneficial, site-specific impacts may be expected, depending on efficiency of capturing carp and other species, extent of effect on native fish, and other factors.

A more important difference between Alternative 2 and 3 is addition of proactive warm-water non-native fish control included in Alternative 3. Warm-water non-native fish control would focus on the LCR Inflow (NPS-managed lands only), Havasu Creek, and Havasu Creek Inflow, inflow of warm-water tributaries where non-native warm-water fish have been captured in the past (e.g., Kanab Creek), and lower portions of Grand Canyon where higher densities of non-native warm-water species exist. Angling

for catfish may be coordinated with the Hualapai Tribe, if the Tribe is interested, for areas downstream of Diamond Creek, where catfish are captured more frequently. Trout would also be targeted proactively in Havasu Creek using angling equipment only, since electro-fishing is not feasible due to water chemistry. A variety of mechanical removal techniques (e.g., electro-fishing, angling, netting) would be used, which may result in additional handling and stress impacts to native species, particularly in the lower portions of Grand Canyon and the LCR area. Risk of injury to HBC or other native species during these efforts would be greatest under Alternative 3, but proactive removal of existing predatory species such as channel catfish and black bullhead, striped bass, and others may lower current predation rates on native species. Proactive warm-water non-native species control would also reduce risk of future expansions in the range of warm-water non-native fish or increases in abundance facilitated by changing river conditions. The scale of benefit of non-native fish control included in Alternative 2 would be expanded under Alternative 3 to downstream (lower) portions of Grand Canyon.

Two 20-day boat-based electro-fishing non-native fish removal trips would be conducted in the Bright Angel Creek Inflow, compared to a single trip under Alternative 2. An additional boat electro-fishing effort in April would result in more thorough reductions of non-native trout, and allow more flexibility in targeting different life-stages of trout, enhancing likelihood of success in meeting objectives for non-native trout removal over a shorter time. However, electro-fishing the same reach with multiple passes twice per year would double risk of injury to native fish. The reduction of predatory trout just prior to or during spring spawning periods for native fish in Bright Angel Creek may allow for higher survival of larval and juvenile native fish, particularly flannelmouth and bluehead suckers, that may disperse from Bright Angel Creek in the Colorado River, which would outweigh negative impacts to individuals due to predation. Comprehensive trout control in Bright Angel Creek and adjacent areas would therefore have a moderate, beneficial, local, long-term impact on native fish in GCNP.

HBC translocations and non-native fish control would be expanded an additional 1.9 miles (3 km) upstream in Shinumo Creek in Alternative 3. Expanding to areas further upstream would lead to a greater carrying capacity for rearing HBC in Shinumo Creek, potentially higher likelihood of reproduction, and reducing potential genetic risks. Duration and intensity of beneficial, local effect of HBC (or other native fish) translocations in GCNP would depend on whether HBC reproduce and develop a second viable spawning aggregation (long-term, moderate effect), or translocation projects function as mechanisms to provide suitable rearing opportunities (short-term, minor effect). Thus, translocations would have moderate, beneficial, local, short- to long-term impacts to HBC.

Alternative 3 Cumulative Effects Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
Cumulative Effects of Alternative 3 are similar to those for Alternative 2 for native fish in GCNP. However, pro-active warm-water non-native fish control included in Alternative 3 combined with other non-native fish control actions conducted by USBR and others would increase potential for maintaining low non-native species abundances across the entire project area.

Alternative 3 Conclusion Environmental Consequences
Impacts to Fisheries
Grand Canyon Native Fish Community
In summary, initial activities and past monitoring results suggest translocations would benefit HBC by achieving a wider distribution and higher abundance in downstream aggregations, potentially leading to a second spawning aggregation in GCNP. While non-native rainbow trout populations in Glen Canyon may continue to fluctuate depending on dam discharge, whirling disease, and other factors, triploid sterile rainbow trout stocking would have minor, short-term, site-specific impacts to native fish. More intensive trout control and pro-active control of warm-water non-native species, combined with non-native fish

control efforts approved by USBR (2012), would help ensure reduced competition with or predation upon native fish in the mainstem, providing moderate, indirect, local (parkwide) benefits to HBC and native fish in the long term. Emergency non-native fish control actions would allow managers to react quickly to future emerging threats, as in Alternative 2. However, pro-active warm-water fish control at potential source areas under Alternative 3 would reduce risk of new invasions or expanded distribution or abundance of existing warm-water non-native species, beyond actions included in Alternative 2, and thus, moderate, beneficial, local, long-term impact on native fish communities would be expected in GCNP.

ETHNOGRAPHIC RESOURCES

Affected Environment

Ethnographic resources are defined by NPS Director's Order 28, Cultural Resource Management, as any "site, structure, object, landscape, or natural resource feature assigned traditional, legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it."

Most ethnographic resources in the park units are associated with tribes considered traditionally associated with GCNP and GCNRA: the Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Las Vegas Tribe of Paiute Indians, Moapa Band of Paiute Indians, Yavapai-Apache Nation, and the Ute Mountain Ute Tribe.

One type of ethnographic resource is a Traditional Cultural Property (TCP), generally defined as a type of historic property eligible for inclusion in the National Register of Historic Places because of association with cultural practices or beliefs of a living community rooted in that community's history, and important in maintaining continuing cultural identity of the community. Traditional cultural values are often central to the way a community or group defines itself, and maintaining such values is often vital to maintaining the group's sense of identity and self-respect. Properties to which traditional cultural values are ascribed often take on this kind of vital significance, so that any damage to or infringement is perceived to be deeply offensive to, and even destructive of, the group that values them.

Such places may not necessarily come to light through cultural resource surveys. Existence and significance of such locations often can be ascertained only through interviews with knowledgeable users or through other forms of ethnographic research (Ferguson, 1998; Hart, 1995; Hualapai Cultural Resources Division of Hualapai Wildlife Management Department, 1993; Roberts et al., 1995; Stevens, 1996; Stoffle et al., 1996). As a result of the GCD Final Environmental Impact Statement, TCPs were identified along the Colorado River corridor by various Traditionally Associated American Indian Tribes (USBR 1995).

Many traditionally associated tribes have identified the Colorado River and its associated elements in Glen, Marble, and Grand Canyons as a TCP. The State Historic Preservation Officer, USBR, and NPS concurred with this.

During prior consultations for USBR's Non-native Fish Removal EA, the Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, and Pueblo of Zuni expressed concern regarding taking of life in the river, especially in the vicinity of the confluence of the Colorado and Little Colorado Rivers. In addition, the Pueblo of Zuni identified the native and non-native fish in the Colorado River as an important contributing element to this TCP. The killing and removal of fish from the river may diminish TCP integrity for the Zuni people since the action would affect the feeling and association of the TCP and could be perceived as offensive to Zuni cultural values if the fish are not used for human consumption.

All of the traditionally associated tribes maintain a strong sense of stewardship responsibility for the canyon's ecological health including placing great value on all plant and animal life.

Environmental Consequences

Methodology **Ethnographic Resources**

Baseline information used to assess effects to Ethnographic Resources is as described in Methodology at the beginning of this chapter, and includes information provided by traditionally associated tribes, park staff knowledge of resources and sites, review of existing literature and park studies, information provided by NPS and other agency agencies specialists, and professional judgment. Additional sources of information on Ethnographic Resources used as a basis for this evaluation are as described in Affected Environment.

Thresholds **Ethnographic Resources**

Thresholds of change on Ethnographic Resources are

Intensity

Negligible Effects at lowest levels of detection, barely perceptible and alter neither resource condition, such as traditional access and site preservation, nor relationship between resource and associated group's body of practices and beliefs. Determination of effect for Section 106 "no adverse effect"

Minor **Adverse** Effects slight and noticeable and neither appreciably alter resource conditions, such as traditional access or site preservation, nor relationship between the resource and associated group's body of beliefs and practices. Determination of effect for purposes of Section 106 "no adverse effect"

Beneficial Effects don't change or diminish traditional access or a group's traditional practices or beliefs. Determination of effect for purposes of Section 106 "no adverse effect"

Moderate **Adverse** Effects apparent and alter resource conditions or interfere with traditional access, site preservation, or relationship between resource and associated group's practices and beliefs, even though the group's practices and beliefs survive. Determination of effect for Section 106 "adverse effect"

Beneficial Effects improve traditional access and/or accommodate a group's practices or beliefs. Beneficial effects include maintaining or restoring natural ecosystem processes. Determination of effect for purposes of Section 106 "no adverse effect"

Major **Adverse** Effect(s) alter resource conditions. Proposed actions block or greatly affect traditional access, site preservation, or relationship between resource and associated group's body of beliefs and practices, to the extent that survival of a group's beliefs and/or practices jeopardized. Impacts result in significant changes or destabilization to defining elements and resource condition and an increase in exposure or vulnerability to natural elements. Determination of effect for purposes of Section 106 "adverse effect"

Beneficial Effects enhance traditional practices and/or accommodate a group's beliefs or practices. Beneficial effects include maintaining or restoring natural ecosystem processes. Determination of effect for purposes of Section 106 "no adverse effect"

Duration

Short term An effect that, within five years, would no longer be detectable as the resource was returned to its predisturbance condition or appearance

Long term A change in a resource or its condition that would not return the resource to predisturbance condition or appearance and for all practical purposes would be considered permanent

Timing Access and traditional practices associated with Ethnographic Resources might be more vulnerable to effects during particular times of year depending on individual tribal traditions

Context

Site-specific The action would affect relatively small park areas centered on where the action takes place

Local The action affects areas in the park boundary

Regional The action affects park resources, lands adjacent to the park, and surrounding communities

Alternative 1 No Action Environmental Consequences
Ethnographic Resources
This Alternative includes continuation of

- Projectwide outreach/aquatic invasive species introduction prevention
- Continued fish population monitoring
- Emergency response to new/expanded populations
- Minimal fish removal, incidental to monitoring
- Angler harvest regulations
- No NPS fisheries management actions in the LCR and Inflow
- No NPS fisheries management actions in Bright Angel Creek and Inflow after March 2013
- Management of Glen Canyon recreational trout fishery through angler harvest regulations
- Havasu and Shinumo Creeks HBC monitoring

Direct and Indirect Effects: Under Alternative 1, monitoring would result in some removal of non-native fish through incidental capture and manipulation of native fish. Effects to Ethnographic Resources would be negligible. Under Section 106 there would be no adverse effect to Ethnographic Resources.

Cumulative Effects: Past, present, and reasonably foreseeable future actions effecting Ethnographic Resources include GCD operations, other fish management projects, and recreational use.

GCD operations have direct, regional, long term moderate adverse effects on Ethnographic Resources from changes to the natural river system including plant and animal life. Other fish management projects including non-native fish removal implemented in the mainstem of the Colorado River by the USBR have direct, regional, long term, moderate, adverse impacts on these resources. Finally, recreational use of the river and recreational fishing have negligible effects due to taking fish. Through previous consultation

with tribes and the Arizona SHPO, it has been determined that dam operations and non-native fish removal have an adverse effect under Section 106.

Cumulative beneficial effects include increased education related to TCPs, opportunities to work with tribes, and restoration of native fish from previous efforts. These effects are minor, beneficial, regional, long term.

Alternative 1 Conclusion Environmental Consequences
Ethnographic Resources
Under Alternative 1, effects to Ethnographic Resources from manipulation and limited removal of fish would be negligible. The negligible effects of Alternative 1 in combination with past, present, and reasonably foreseeable future actions would have a moderate, adverse, regional, long-term effect on Ethnographic Resources. Under Section 106, the no adverse effect of Alternative 1 in combination with the adverse Cumulative Effects would result in an adverse effect to Ethnographic Resources.

Alternative 2 Moderate Intensity Management Environmental Consequences
Ethnographic Resources
This Alternative emphasizes restoration of native fish communities primarily through translocation of HBC and other native species and uses some non-native fish control, more than Alternative 1, but less than Alternative 3. It includes

- Actions described under Alternative 1 would continue, including outreach and monitoring activities, and management of the recreational trout fishery in Glen Canyon through angler harvest regulations
- The Glen Canyon Reach recreational trout fishery would be maintained and stocking of sterile (non-reproducing) trout would occur in event of a severe trout population decline.
- Allow for possibility of an emergency response for the removal of non-native fish if a new non-native introduction were to occur or if existing non-native fish populations increased to the degree they threatened native populations. The degree to which this would occur is difficult to estimate because it is dependent on the nature, extent, and location of the invasion
- Removal of incidental captures of high-risk fish predators during monitoring: non-native fish caught during monitoring (brown trout, catfish, striped bass, walleye, or sunfish) would be removed and euthanized rather than released alive back into the system. As much as practical, non-natives would be put to beneficial use through human consumption
- Targeted volunteer fishing to remove up to 2,000 rainbow trout annually from Marble Canyon (the area from the Paria River to a point upstream of the LCR)
- As discussed in the USBR's Non-native Fish Control EA and Biological Opinion (2011), a comprehensive brown trout control program is proposed to increase effectiveness in controlling brown trout in Grand Canyon and Bright Angel Creek. Trout would be controlled in the Colorado River (one trip/year) through electro-fishing near and in Bright Angel Creek, and using a weir/fish trap in fall/winter. In the first year, numbers of trout anticipated to be removed ranges 9,600 to 18,700. In year two or three, based on the large reductions accomplished during the first year, a much smaller number of trout would need to be removed, perhaps 80% less than the first or second years (2,400-6,100 trout)
- Shinumo Creek HBC translocation and trout control involving removal 200-1,200 trout per year
- Consistent with park practices, human consumption of as many euthanized fish as possible would continue

Direct and Indirect Effects: Restoration of natural processes through translocation of native fish and non-native fish control proposed in this Alternative may be perceived as beneficial to Ethnographic Resources by some tribes. However, under Alternative 2 there may be stocking of sterile trout in GCNRA

(depending on triggers, see Chapter 2), and manipulation and removal of fish, a contributing element to the TCP. Consistent with ongoing practices, human consumption of euthanized fish would continue to the extent possible, although it is unlikely all fish would be consumed. Consumption of fish would lessen the impact to the TCP, based on comments received from traditionally associated tribes. Manipulation and removal of fish under Alternative 2 would have moderate, adverse, regional, long-term effects. Beneficial restoration and natural processes in combination with adverse manipulation and removal of fish would have minor to moderate adverse, regional, long-term effects. Under Section 106 there would be an adverse effect to Ethnographic Resources.

Cumulative Effects: Past, present and reasonable foreseeable future actions impacting Ethnographic Resources include GCD operations, other fish management projects, and recreational use.

GCD operations have direct, regional, long-term moderate adverse effects on Ethnographic Resources due to changes to the natural river system, including plant and animal life. Other fish management projects including non-native fish removal being implemented in the mainstem of the Colorado River by the USBR (USBR 2012b) have moderate, adverse, regional, long-term impacts on these resources. Recreational use of the river and recreational fishing has negligible, adverse, regional, long-term impacts from taking fish. Through previous consultation with tribes and the Arizona SHPO, it has been determined that the dam operations and non-native fish removal have an adverse effect under Section 106.

Cumulative beneficial effects include increased education related to TCPs, opportunities to work with tribes, and restoration of native fish. These beneficial effects are long term, minor. Under Section 106 there would be no adverse effect to Ethnographic Resources.

Cumulatively, effects of Alternative 2, when combined with other past, present, and reasonably foreseeable future actions would result in moderate, adverse, regional, long-term effects on Ethnographic Resources, particularly the Colorado River TCP. Under Section 106 there would be an adverse effect to Ethnographic Resources.

Alternative 2 Conclusion Environmental Consequences
Ethnographic Resources
Effects of Alternative 2 in combination with past, present, and reasonably foreseeable future actions (i.e., Cumulative Effects) would result in moderate, adverse, regional, long-term effects. The finding of effect under Section 106 of Alternative 2implementation would be adverse effect to Ethnographic Resources.

Alternatives 3 Intensive Management Environmental Consequences
Ethnographic Resources
This Alternative emphasizes a more intensive or proactive native fish community restoration than the prior Alternatives primarily through a series of non-native fish control efforts and native fish translocations. In addition to actions previously mentioned in Alternative 2, Alternative 3 includes

- A higher removal rate for incidental captures of high-risk predators caught during monitoring including common carp
- Targeted and proactive control of warm-water non-native fish congregations at areas including the Little Colorado Inflow, Havasu Creek and the Colorado River near the mouth of Havasu Creek, Kanab Creek, and areas of the river below Lava Falls. Anglers below Diamond Creek would remove catfish. It is possible that several thousand additional fish could be removed under this action
- An additional non-native trout removal trip for Bright Angel Creek (two trips/year)
- Geographic expansion including three additional kilometers of stream for Shinumo Creek trout control, possibly doubling in number the amount of trout removed

Direct and Indirect Effects: Restoration of natural processes through native fish translocation and non-native fish control proposed in this Alternative may be seen as beneficial to Ethnographic Resources by some tribes. However, under Alternative 3, there may be stocking of sterile trout in GCNRA (depending on triggers, see Chapter 2), and manipulation and removal of fish, which are a contributing element to the TCP. Non-native fish control would be implemented at a greater intensity than in Alternative 2. Consistent with ongoing practices, human consumption of euthanized fish would continue to the extent possible, although it is unlikely all fish would be consumed. In Alternative 3, more non-native fish would be euthanized when compared to Alternative 2, resulting in a smaller proportion of non-native fish being consumed than in Alternative 2. Adverse effects to Ethnographic Resources under Alternative 3 would be moderate, adverse, regional, long term. Under Section 106 there would be an adverse effect to Ethnographic Resources.

Cumulative Effects: Past, present and reasonable foreseeable future actions effecting Ethnographic Resources include GCD operations, other fish management projects, and recreational use.

GCD operations have adverse moderate long-term effects on Ethnographic Resources from changes to the natural river system including plant and animal life. Other fish management projects including USBR non-native fish removal being implemented in the mainstem of the Colorado River have moderate, adverse, regional, long-term effects on these resources. Finally, recreational use of the river and recreational fishing has negligible adverse effects due to taking fish. Through previous consultation with tribes and the Arizona SHPO, it was determined dam operations and non-native fish removal have an adverse effect under section 106.

Cumulative beneficial effects include increased education related to TCPs, opportunities to work with tribes, and restoration of native fish. These beneficial effects are long term minor. Under Section 106, cumulative beneficial effects, would have no adverse effect to Ethnographic Resources.

Overall, Cumulative Effects would result in moderate, adverse, regional, long-term effects to Ethnographic Resources, particularly the Colorado River TCP. Under Section 106 there would be an adverse effect to Ethnographic Resources.

Conclusion
The effect of Alternative 3, in combination with past, present, and reasonably foreseeable future actions would have a moderate, adverse, regional, long-term effect to Ethnographic Resources. Implementation of Alternative 3 would result in an adverse effect to Ethnographic Resources under Section 106.

VISITOR USE AND EXPERIENCE

Affected Environment

The Colorado River and its tributaries in GCNRA and GCNP offer exceptional natural beauty with varied opportunities for visitors to explore and enjoy the river corridor and park resources. Visitor Experience in both park units, as it relates to fisheries, include opportunities to fish for rainbow trout in GCNRA's Glen Canyon Reach, which has been referred to as "blue ribbon" by the State of Arizona, and to fish for rainbow and brown trout and a variety of non-native introduced fish species in the main stem Colorado River and some tributaries in GCNP. Most angling in GCNP occurs in or near Bright Angel Creek and Phantom Ranch, particularly in fall and spring (NPS 2006c). Most success for anglers would be expected in GCNP from the Paria River to areas upstream of the LCR where trout abundance is highest (AZGFD fisheries monitoring data, Bunch et al. 2012). This area is accessible by rafting or hiking remote trails.

Fishing on the Colorado River is more common upstream or downstream of the GCNP boundary, in GCNRA or Lake Mead Recreation Area (NPS 2005).

Visitor Experience issues relating to fisheries management differs for GCNRA and GCNP due to the level and types of river- and backcountry-related activities in each park. Proposed CFMP management actions in GCNRA and GCNP would take place in Fish Management Zones. FMZs are listed in Table 1.1.

GCNRA - GCNRA visitation was 2.27 million people in 2011; 178,922 in the Lees Ferry District (NPS 2012). The Lees Ferry District includes the 15-mile stretch of the Colorado River from GCD to Lees Ferry with backcountry campsites, a public boat ramp for GCNRA and GCNP visitors, a campground, Paria beach, and the Lees Ferry Historic District. Activities include fishing, boating, sight-seeing, hiking, camping and visiting cultural resources.

Approximately 50,000 visitors per year experience the Glen Canyon Reach on guided raft trips from GCD to Lees Ferry boat ramp operated by an NPS concessioner. The commercial outfitter also provides a backhaul service to transport people and small watercraft (kayaks and canoes) upstream, enabling them to take an overnight camp or day trip in the 15-mile river segment below GCD. Visitors also visit the Glen Canyon Reach to fish, with many anglers participating in commercially guided trips. Between 2009 and 2011, 8,048 people participated in guided fishing trips on the Colorado River in GCNRA, averaging 2,682 people per year during this period. In addition, an average 1,000 anglers visited Lees Ferry that did not use commercial guides and who fish from shore, bring their own boats, or rent boats (Anderson et al. 201).

GCNP – Grand Canyon National Park was visited by 4.36 million people in 2011 (NPS 2012). Approximately 94% of GCNP is proposed for Wilderness designation including the backcountry and Colorado River corridor. Visitors participating in river trips identified the level of naturalness, peace and quiet, and opportunities to experience solitude as important qualities of a river trip (Hall and Shelby 2000). Likewise, backcountry visitors identified the natural setting, solitude, and challenge as important qualities or motivations for engaging in backcountry travel in GCNP (Backlund et.al 2008). Wilderness Character and values are discussed in a separate section of this document.

The GCNP Colorado River Management Plan sets visitor use limits and resource management actions for 278 miles of the Colorado River from Lees Ferry to Lake Mead (NPS 2006b). Approximately 24,000 visitors participate in commercial and noncommercial river trips each year. The CRMP set a visitor capacity of 60 trips at one time (1,100 people) based on campsite size and location and other resource factors. During peak summer months, a maximum six trips (motorized and non-motorized) launch each day. Summer trips range from six to 16 days, and maximum group size is 32 people. During spring, fall, and winter, there are one to three daily launches, and trips last up to 30 days. The six-month non-motorized use period (late September through March), combined with longer trips allows river users to experience outstanding opportunities for solitude, natural quiet, and other values compatible with Wilderness Character.

GCNP and the Hualapai Nation share a 108-mile boundary along the Colorado River in the western canyon. Diamond Creek, located at river mile 225, is accessible by a road on the Hualapai reservation. Approximately one-half of trips launching at Lees Ferry terminate at Diamond Creek, and other trips terminate at Pearce Ferry in LAKE. Hualapai River Runners conduct one-day river trips from Diamond Creek to the Quartermaster Canyon areas near RM 263, where visitors debark and take helicopters to the rim. In addition to river trips, the Hualapai operate short pontoon trips on the smooth-water section of the Colorado River near Quartermaster Canyon. River activities in this area, combined with sight-seeing helicopter flights landing on tribal lands, provide a very different type of experience for visitors. Visitor use statistics for river trips in this area are not available.

The GCNP Backcountry Management Plan (1988) addresses visitor use and resource protection of proposed Wilderness and other backcountry areas. The Colorado River is a popular destination for many of Grand Canyon's 37,000 overnight backpackers and thousands of day hikers. Approximately 56% of backpackers camp overnight in the popular Cross-Canyon Corridor that includes three campgrounds and a trail system that links South Rim to North Rim. Phantom Ranch is a concession-operated lodge that can hosts 80 guests; together Phantom Ranch's Bright Angel Campground and lodge can accommodate 170 overnight visitors. The lodge and campground are directly adjacent to Bright Angel Creek where some proposed fish management actions would occur. Other administrative facilities in Phantom Ranch include a ranger station, sewage treatment plant, and various support facilities.

Environmental Consequences

Methodology **Visitor Use and Experience**

This impact analysis will determine if proposed actions would be compatible or in conflict with park purpose and direction provided by NPS 2006 Management Policies (e.g., Section 8.2, NPS 2006a) and each park's management goals. Policies and goals were integrated into impact thresholds. Current, past, future, and cumulative resource use and management actions were considered to analyze potential positive and negative effects of native fish conservation activities on Visitor Use and Experience. Baseline information used to assess impacts to Visitor Experience is as described in Chapter 3, Methodology, and includes park staff resources and site knowledge, review of existing literature and park studies, information provided by NPS and other-agency specialists, and professional judgment. Additional sources of Visitor Experience information used in this evaluation are described in Affected Environment.

Thresholds **Visitor Use and Experience**

Thresholds of change on Visitor Experience are defined as

Intensity

Negligible A majority of all visitors don't notice any effects of changes in visitor use patterns and levels, and effects don't change their experience of park resources and values. Mitigation unnecessary

Minor Visitors might detect effects of changes in visitor use patterns and levels, and changes might have a slight but detectable effect on experience of park resources and values. If mitigation needed to offset adverse effects to visitor experience, it would be relatively simple to implement and likely successful

Moderate Visitors aware of effects of changes in visitor use patterns and levels, as well as effects on experience of park resources and values. Some visitors might feel displaced and need to pursue their desired visitor experience in another area of the park or outside the park. Mitigation measures probably necessary to offset adverse effects and likely successful

Major A majority of visitors highly aware of effects associated with changes in visitor use patterns and levels, and effects on experience of park resources and values. Many visitors feel displaced and need to pursue their desired visitor experience in other areas of the park or outside the park. Mitigation measures to offset adverse effects needed, extensive, and success not guaranteed

Duration Short term A temporary effect that largely disappears over a period of hours or days
Long term An effect that lasts months or years

Context Site-specific impacts affect small park areas, where specific action occurs, while local impacts occur across the park, but not beyond park boundaries

Regional impacts extend beyond the project area in the Colorado River Basin

Alternative 1 No Action Environmental Consequences
Visitor Use and Experience Direct and Indirect Impacts

Actions performed under the No Action Alternative are ongoing and approved under previous planning documents. Thus, implementation of the No Action Alternative would result in no changes to existing visitor experience at GCNP and GCNRA. Under the No Action Alternative, proactive restoration of native fish would not occur in Grand Canyon tributaries beyond 2013, and GCNRA recreational trout fishery management would continue through fishing regulations.

GCNRA - The quality of the Glen Canyon Reach fishery has a direct impact on Visitor Use and Experience. In the Glen Canyon Reach, opportunities for visitors to fish for rainbow trout would continue, and rainbow trout populations would continue to be managed in accordance with GCNRA enabling legislation and through angler harvest regulations. If fishery quality does not decline, the No Action Alternative would not result in an impact to Visitor Use and Experience. However, abundance and condition of rainbow trout would continue to fluctuate in response to multiple factors, including GCD operations and recently detected whirling disease or other elements that influence abundance and quality of rainbow trout populations. No other active management would occur, without additional planning and compliance, to maintain the sport fishery during or after a population decline. If fishery quality declines, the No Action Alternative could result in long-term, local, moderate adverse impacts to opportunities for recreational trout fishing in the Glen Canyon Reach. Impact to other Glen Canyon recreational Visitor Use would be negligible.

Alternative 1 No Action Environmental Consequences
Visitor Use and Experience Direct and Indirect Impacts

GCNP Angling

Opportunities for angling for non-native fish in Bright Angel Creek will remain unchanged, and could result in short- to long-term minor, local, beneficial impacts to those seeking these opportunities. Impacts would be similar to those discussed in the Bright Angel Creek Trout Reduction EA (NPS 2006c) for angling experience. Existing management activities have potential to enhance native fish populations, and opportunities would continue for encountering native fish species that are still present in GCNP. Continuation of monitoring programs could result in a short-to long-term, minor beneficial impact to visitor opportunities to encounter native fish.

Alternative 1 No Action Environmental Consequences
Visitor Use and Experience Direct and Indirect Impacts

GCNP River and Backcountry Experience

Key factors or indicators for experience quality include encounters with motorized and non-motorized river trips, campsite competition, noise disturbance, and visual intrusions (NPS 2006b, 1988). Existing impacts to Visitor Experience related to NPS fisheries management projects (translocations, mechanical removal of non-native fish, monitoring) include presence of crews, human-made noise and visual impacts from motorized and non-motorized transportation, scientific equipment and gear. These projects would end in 2013 as compliance documents expire. NPS monitoring of past work and NPS-permitted fisheries monitoring or research activities conducted by cooperating agencies would continue. On-river encounters and site-specific encounters with recreational river trips and backpackers may result in short-term, minor,

site-specific adverse impacts to Visitor Use and Experience. Conversely, encounters with fisheries crews may provide an opportunity for visitors to interact and learn about park resources, resulting in a minor beneficial impact to experience.

Conservation measures developed to mitigate impacts to HBC related to GCD, including expanded brown trout control at Bright Angel Creek, future HBC translocations, tributary rainbow trout control, and actions developed to meet HBC recovery criteria would not be implemented under the No Action Alternative without additional planning and compliance. Extirpated species would not be reintroduced, although feasibility studies may occur. Emergency response for controlling new invasions of non-native fish or ANS, or expanded populations of existing non-native species would be taken, if necessary. Alternative 1 could result in reduced numbers of native fish species and thus long-term, moderate, site specific adverse impacts to opportunities for visitors to encounter native fish in GCNP.

Alternative 1 No Action Environmental Consequences
Visitor Use and Experience Direct and Indirect Impacts
Cumulative Effects

Cumulative Effects on Visitor Use and Experience were assessed by combining impacts of Alternative 1 with the following other past, present, and reasonably foreseeable future impacts

- Plans and actions with impacts in areas where fisheries management activities will take place
- Activities which include recreational tourism, rafting, hiking, camping and fishing
- Plans
    - USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
    - GCD LTEMP EIS (USBR, NPS in progress) for GCD operation
    - GCNRA General Management Plan (1979)
    - Lees Ferry Improvements EA (2006)
    - Paria River Stabilization and Lees Ferry Road Rehabilitation EA (2012)
    - Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
    - GCNP BMP EA (NPS 1988)
    - GCNP CRMP EIS (NPS 2006b)

Cumulative Effects of past, present, and reasonably foreseeable actions and plans, resulting Visitor Use and Experience impact to GCNRA and GCNP would be short and long term, minor. Adverse impacts may result from encounters with science crews and noise associated with motorized equipment operations. Beneficial impacts to Visitor Experience may result from increased education opportunities related to fish and endangered species management. Implementing the No Action Alternative may contribute in a measurable way to Cumulative Effects of other past, present, and reasonably foreseeable future plans and actions.

Alternative 1 No Action Environmental Consequences
Visitor Use and Experience Direct and Indirect Impacts
Conclusion

Alternative 1 adverse impacts to Visitor Experience would result from a potential decline in the quality of the Glen Canyon Reach fishery and presence of fisheries crews in GCNP backcountry and river, especially if mechanized equipment is used. Adverse impacts would be site-specific and localized short to long term, minor to moderate. Beneficial impacts including overall actions to restore native ecosystems would be localized, long term, minor. Cumulative Effects would be minor.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Direct and Indirect Impacts
GCNRA

The quality of the Glen Canyon Reach fishery has a direct impact on Visitor Use and Experience. Glen Canyon Reach opportunities for visitors to fish for rainbow trout would continue, and rainbow trout populations would continue to be managed in accordance with GCNRA enabling legislation and through angler harvest regulations. Experimental stocking of triploid/sterile rainbow trout is intended to improve recreational fishery quality. While many uncertainties exist regarding success of triploid stocking related to increasing trout maximum size and higher growth rates, it is assumed stocking would result in long-term moderate beneficial impacts to Glen Canyon Reach recreational trout fishing because visitors may not be displaced due to maintenance of high-quality fishing opportunities. If stocking does not improve fishery quality, impacts would be the same as Alternative 1. Impacts to other recreational Glen Canyon Visitor Use would be negligible.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
GCNP Angling

Under Alternative 2, activities associated with native fish restoration that may impact Visitor Experience related to angling opportunities include comprehensive non-native trout control projects in and around Bright Angel Creek or other tributaries where trout reduction activities are focused. Additional tributaries may be targeted for mechanical removal efforts depending on brown trout natal origin studies, and non-native trout control associated with monitoring efforts or HBC translocation projects would occur. However, impacts to angling opportunities in other areas would not be noticeable. Impacts would be similar to those discussed in the Bright Angel Creek Trout Reduction EA (NPS 2006c) for angling experience, except a more comprehensive approach would being taken to more effectively reduce non-native trout across the entire project area. This comprehensive approach would be expected to be more effective in reducing non-native fish species, including non-native fish such as trout, in GCNP. Under this Alternative, quality of angling in Bright Angel Creek would continue to be reduced. During trout spawning season in fall and winter, abundance of trout immediately upstream of the weir would continue to be diminished, although in the first years of the project recreational fishing would still be productive downstream of the weir and along the banks of the Colorado River. Not all non-native trout can be feasibly removed using mechanical removal (i.e., electro-fishing/netting) methods. Based on mathematical modeling of trout populations, and experiences in other areas (see Meyers et al. 2006) it is expected the abundance of young-of-year and small trout may temporarily increase following the first year or two of comprehensive trout control implementation. This is the result of increased survival of fingerlings produced by remaining adult fish due to reduction of competition by adults.

Over subsequent years, as returning or remaining trout are eliminated in both the mainstem and in Bright Angel Creek, quality of angling would decline. Eventually, few trout would be available anywhere in Bright Angel Creek, but some trout would always be available in the Colorado River, particularly upstream of LCR. A small portion of visitors to the area would still fish as an incidental part of their experience, but fewer individuals would travel to the area solely or principally to fish. Smaller scale non-native fish control activities would continue to be implemented at Shinumo Creek, brown trout captured from anywhere in the park during monitoring efforts, and rainbow trout captured in tributaries during monitoring, and high-priority predator fish species captured incidentally would also be removed. The decline of the Bright Angel Creek sport fishery would be felt by an estimated 200 visitors per year, but for the overwhelming majority of park visitors, the change would go unnoticed (NPS 2006c). Consequently, impacts to Visitor Experience would be long term moderate adverse for those seeking angling opportunities at Bright Angel Creek or other tributaries.

Initiation of river trips, in collaboration with AZGFD, to support volunteer anglers for removal of trout, mainly targeting Marble Canyon areas of GCNP (upstream of LCR), would provide an alternative to Bright Angel Creek for anglers to experience angling in GCNP. These trips would provide a trout angling opportunity while contributing toward reduction of non-native fish in GCNP.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
GCNP River and Backcountry Experience
Key factors or indicators for experience quality include encounters with motorized and non-motorized river trips, campsite competition, noise disturbance, and visual intrusions (NPS 2006b, 1988). Impacts to Visitor Experience related to NPS fisheries management projects (translocations, mechanical removal in tributaries and the mainstem, and monitoring) include presence of crews, human-made noise and visual impacts from motorized and non-motorized transportation, scientific equipment and gear.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Translocation
Under Alternative 2, monitoring trips associated with HBC translocations at Shinumo, Havasu, and Bright Angel Creeks would occur two to three times each year. HBC translocations require helicopter transportation of juvenile fish to the site, which would occur up to once per year at each translocation site, and for transportation of gear and food to support fisheries crews conducting monitoring efforts at Havasu Creek for periods of 7 to 12 days at one site. A remote PIT-tag antenna monitoring station located at the Shinumo Creek translocation area records tagged HBC and other native fish as they move up and downstream, providing biologists with information related to survival, movement, and factors causing translocated HBC to leave Shinumo Creek. This temporary structure consists of four solar panels, storage box, and two antennae consisting of six-inch PVC pipes across the creek. Temporary installation of PIT-tag antenna systems may be considered for other translocations sites in the future, including Bright Angel Creek. Crews will access each site via hiking or river. Visitors expecting a Wilderness experience are more sensitive to effects of helicopters, motorized craft, and structures in proposed Wilderness. Implementation of Alternative 2 translocation activities could result in minor, adverse, site-specific, short-term impacts to Visitor Experience.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Tributary non-native fish control
Under Alternative 2, non-native fish control would be conducted in Bright Angel, Shinumo and Havasu Creeks in combination with monitoring activities. At Bright Angel Creek, non-native fish control will take place during fall/winter (September to early March) using electro-fishing and a weir. Impacts to Visitor Experience include visual impacts, and presence of crews removing live fish from the creek. The Cross-Canyon Corridor and Phantom Ranch host thousands of visitors annually, and high encounter rates are expected; however, at times the crew may not be noticeable while working in creek areas distant from North Kaibab Trail. Human-made noise in this area is common due to number and types of facilities at Phantom Ranch and other administrative areas.

At Shinumo Creek, non-native fish control would be conducted primarily by electro-fishing and angling. Havasu Creek non-native fish control involves use of nets only. Crews working at Havasu Creek will access each site via hiking or river, with support by helicopter (drops of water/food/gear, according to MRA). Impacts to Visitor Experience include river and trail encounters, and scientific equipment noise and visual impacts. Occasional short-term (up to ½ hour) noise impact due to helicopter gear transport may occur up to five times per year.

Implementation of Alternative 2 non-native control activities could result in short-term, moderate, site-specific adverse impacts to Visitor Experience at Shinumo and Havasu Creeks in proposed Wilderness, and short-term, minor, site-specific adverse impacts at Bright Angel Creek in the Non-Wilderness Cross-Canyon Corridor.

During early implementation as proposed under Alternative 2, mainstem/inflow non-native fish control will be conducted in one of the FMZs: Bright Angel Creek and Adjacent Mainstem: a five-mile segment between Zoroaster Rapids and Horn Creek Rapid (River miles 84.7 – 90.2). However, if non-native fish increase or expand in the mainstem and control effort triggers are met, mainstem non-native fish control would be most likely to occur at 1) Havasu Creek and Adjacent Mainstem: a two-mile segment immediately upstream and downstream of the confluence, 2) between Lava Falls and Lake Mead, and 3) in the vicinity of Kanab Creek, and the LCR Inflow. Fisheries activities involve use of motorized watercraft and generator-powered electro-fishing equipment. Bright Angel FMZ work would be conducted in November during the non-motorized period for up to 20 nights and requires use of spotlights. Scientists expect duration of nighttime activities would decrease over time. Control efforts in the mainstem related to non-native fish abundance triggers would be similar. Havasu and Shinumo Creek FMZ work in tributaries would be conducted in combination with translocation and monitoring trips during daytime hours only, up to three times per year for up to 12 days. Impacts to Visitor Experience include river encounters, motorized boat and scientific equipment noise and visual impacts, and light intrusions during night. Implementation of Alternative 2 mainstem non-native fish control could result in short-term, moderate, site-specific adverse impacts to visitors experiencing night activities during non-motorized use period; impacts resulting from day-time activities only could result in short-term, minor, site-specific adverse impacts.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Visitor Education and Outreach
Similar to Alternative 1, fisheries management activities provide educational opportunities to the public. Visitors are afforded the unique opportunity to encounter endangered HBC or other native fish, and learn more about resource stewardship efforts, thereby resulting in minor beneficial impacts to Visitor Experience.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Visitor Education and Outreach
Cumulative Effects
Cumulative Effects on Visitor Use and Experience were assessed by combining impacts of Alternative 2 with the following past, present, and reasonably foreseeable future effects

- Plans and actions with impacts in areas where fisheries management activities take place
- Activities which include recreational tourism, rafting, hiking, camping and fishing
- Plans
    - USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
    - GCD LTEMP EIS (USBR, NPS in progress) for operation of GCD
    - GCNRA General Management Plan (1979)
    - Lees Ferry Improvements EA (2006)
    - Paria River Stabilization and Lees Ferry Road Rehabilitation EA (2012)
    - Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
    - GCNP BMP EA (NPS 1988)
    - GCNP CRMP EIS (NPS 2006b)

Cumulative Effects of past, present, and reasonably foreseeable actions, and resulting Visitor Use and Experience impact to GCNRA and GCNP would be short and long term, moderate site-specific adverse. Adverse impacts may result from encounters with fisheries and science crews and noise associated with motorized equipment operations. Anglers seeking recreational fishing at Bright Angel Creek for trout or other tributaries would be adversely affected by the decline in non-native fish populations. Minor beneficial impacts to Visitor Experience may result from increased education opportunities related to fish and endangered species management. Alternative 2 may contribute in a measurable way to Cumulative Effects of other past, present, and reasonably foreseeable future actions.

Alternative 2 Moderate Intensity Management Environmental Consequences
Visitor Use and Experience
Conclusion

Alternative 2 beneficial impacts to Visitor Experience would result from avoidance of potential decline in the quality of the Glen Canyon Reach fishery through sterile trout stocking; however, adverse impacts to anglers, and backcountry and river users due to encounters, use of motorized equipment, and presence scientific structures and equipment in GCNP backcountry and Wilderness would occur. Adverse impacts would be short to long term, moderate, especially during the non-motorized use period when nighttime management activities occur. Beneficial impacts including overall actions to restore native ecosystems would be short to long term moderate. Cumulative Effects would be minor to moderate.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
Direct and Indirect Impacts
GCNRA

Glen Canyon Reach fishery quality has a direct impact on Visitor Use and Experience. Opportunities for recreational fishing for rainbow trout would continue to be available, and rainbow trout populations would continue to be managed in accordance with GCNRA enabling legislation and through angler harvest regulations. Proposed experimental stocking of triploid/sterile rainbow trout would be intended to improve quality of the recreational rainbow trout fishery. While many uncertainties regarding success of triploid stocking related to increasing trout maximum size and higher growth rates exist, it is assumed stocking would result in long-term moderate beneficial impacts to recreational trout fishing because visitors may not be displaced due to maintenance of high-quality fishing opportunities. If stocking does not improve fishery quality, impacts would be the same as Alternative 1, No Action. Impacts to other recreational visitor uses at Glen Canyon would be negligible.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
GCNP Angling

Impacts to angling experience in Alternatives 2 and 3 are similar because the GCNP main area offering a sport fish angling experience, Bright Angel Creek, would also be targeted for trout control. In Alternative 3, proactive control of warm-water non-native fish, and volunteer angling trips below Diamond Creek in Lower Grand Canyon FMZ may be organized to remove catfish and other non-native fish, and a second mainstem mechanical removal trip in the Bright Angel Creek Inflow would occur. Warm-water non-native fish are not generally the target of anglers, and thus negligible impacts would be expected to the angling experience. The second mainstem removal trip around Bright Angel Creek may result in more effective trout control, but long term, little difference between Alternatives 2 and 3 related to this activity would be noticed by anglers. Other expanded or more intensive non-native control activities such as mechanical trout removal from 4.3 miles (7 kilometers) of Shinumo Creek would have negligible impacts on angling since very few anglers visit that area of the remote backcountry. Opportunities for angling in

Havasu Creek would decline slightly, as trout and other non-native fish are targeted for removal using angling equipment. Few visitors, of the many that visit Havasu Creek, are there specifically for angling.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
GCNP River and Backcountry Experience

Key factors or indicators for experience quality include encounters with motorized and non-motorized river trips, campsite competition, noise disturbance, and visual intrusions (NPS 2006b, 1988). Impacts to Visitor Experience related to NPS fisheries management projects (translocations, mechanical removal in tributaries and the mainstem, and monitoring) include presence of crews, human-made noise and visual impacts from motorized and non-motorized transportation, scientific equipment and gear.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
Translocation

Same as Alternative 2, HBC translocations and monitoring trips at Shinumo, Havasu, and Bright Angel Creeks would occur two to three times each year. Translocation requires helicopter transportation of juvenile fish to the site, and fisheries crews to handle fish and monitor conditions for periods of up to seven days at one site. As in Alternative 2, a remote PIT-tag antenna monitoring station located at Shinumo Creek, and possibly other sites, would be maintained for three years. Crews will access each site via hiking or river. Visitors expecting a Wilderness experience are more sensitive to effects of helicopters, motorized craft, and structures in proposed Wilderness. Alternative 3 translocation activities could result in short-term, minor, site-specific adverse impacts to Visitor Experience.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
Tributary non-native fish control

Impacts are similar to Alternative 2 with exception of Shinumo Creek. At Shinumo Creek, non-native fish control would be conducted by electro-fishing three or more times each year. Additional monitoring and non-native control activities would require use of a spike camp that may require use of helicopter transport of gear and supplies to support crews for longer periods. Crews will access each site via hiking or river travel, and gear may be transported by helicopter or boats. Impacts to Visitor Experience include river and trail encounters, helicopter and motorized or non-motorized boat noise and visual impacts, and scientific equipment noise and visual impacts. Alternative 3 non-native control translocation activities could result in short-term, moderate, site-specific adverse impacts to Visitor Experience at Shinumo and Havasu Creeks in proposed Wilderness, and short-term, minor adverse impacts at Bright Angel Creek in the non-Wilderness Cross-Canyon Corridor.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
Mainstem /inflow non-native fish control

Impact sare similar to Alternative 2, with exception of Bright Angel Creek FMZ. Fisheries activities involve use of motorized craft and generator-powered electro-fishing equipment. Bright Angel FMZ work would be conducted in April during the motorized/non-motorized use period and November during the non-motorized period. Each sampling period will last up to 20 nights and require use of spot lights. Scientists expect duration of night activities to decrease over time. Shinumo Creek and Havasu Creek FMZ work would be conducted in combination with translocation and monitoring trips during daytime only. Impacts to Visitor Experience include river encounters, motorized boat and scientific equipment noise and visual impacts, and light intrusions during night. Implementation of Alternative 3 mainstem non-native fish control could result in short-term, moderate, site-specific adverse impacts to Visitor Experience.

Alternative 3 Intensive Management Environmental Consequences
Visitor Education and Outreach
Similar to Alternatives 1 and 2, fisheries management activities provide educational opportunities to the public. Visitors are afforded the unique opportunity to encounter endangered HBC or other native fish, and learn about resource stewardship efforts, thereby resulting in minor beneficial impacts to Visitor Experience.

Alternative 3 Intensive Management Environmental Consequences
Visitor Use and Experience
Cumulative Effects
Cumulative Effects on Visitor Use And Experience were assessed by combining impacts of Alternative 3 with the following past, present, and reasonably foreseeable future effects

- Plans and actions with impacts in areas where fisheries management activities will occur
- Activities which include recreational tourism, rafting, hiking, camping and fishing
- Plans
    - USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
    - GCD LTEMP EIS (USBR, NPS in progress) for operation of GCD
    - GCNRA General Management Plan (1979)
    - Lees Ferry Improvements EA (2006)
    - Paria River Stabilization and Lees Ferry Road Rehabilitation EA (2012)
    - Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
    - GCNP BMP EA (NPS 1988)
    - GCNP CRMP EIS (NPS 2006b)

Cumulative Effects of past, present, and reasonably foreseeable actions, and resulting Visitor Use and Experience impact to GCNRA and GCNP would be short and long term, moderate site-specific adverse. Adverse impacts may result from encounters with fisheries and science crews and noise associated with motorized equipment operations. Anglers seeking recreational fishing for trout at Bright Angel Creek or other tributaries would be adversely effected by the decline in non-native fish populations. Minor beneficial impacts to Visitor Experience may result from increased education opportunities related to fish and endangered species management. Alternative 3 may contribute in a measurable (minor to moderate) way to the Cumulative Effects of other past, present, and reasonably foreseeable future plans and actions.

Alternative 3 Intensive Management Affected Environment
Visitor Use and Experience
Conclusion
Alternative 3 beneficial impacts to Visitor Experience would result from avoidance of a potential decline in Glen Canyon Reach fishery quality; however, adverse impacts to anglers, backcountry and river users due to encounters, and use of motorized equipment, and presence scientific structures and equipment in backcountry and Wilderness would occur in GCNP. Adverse impacts would be short to long term, minor to moderate, especially during the non-motorized use period when night management activities occur. Beneficial impacts including overall actions to restore native ecosystems would be short to long term moderate. Cumulative Effects would result in minor to moderate impacts.

WILDERNESS CHARACTER

Affected Environment

As required by the Wilderness Act of 1964, NPS completed studies to determine portions of GCNP and GCNRA suitable for Wilderness designation. Based on Wilderness Act criteria, NPS determined 588,855 acres (47%) of GCNRA, and 1.1 million acres (94%) of GCNP qualified for Wilderness designation. Portions of suitable Wilderness in each park unit qualify as potential Wilderness due to temporary, non-conforming or incompatible conditions as defined by the Wilderness Act.

GCNRA Wilderness Character Affected Environment

A portion of proposed Wilderness is below GCD along the Colorado River's west bank. The river's fluctuating surface serves as the Wilderness boundary (NPS 1979). GCD, completed in 1963, was constructed for water storage and flood control (power generation is incidental to primary purpose). GCNRA provides for public enjoyment through diverse land- and water-based recreational opportunities, and protects scenic, scientific, natural, and cultural resources on Lake Powell, the Colorado River and its tributaries, and surrounding lands. While a large portion of GCNRA qualifies for Wilderness designation (NPS 1979), GCD operations manipulate the river ecosystem in GCNRA's Glen Canyon Reach and in GCNP along the Colorado River.

GCNP Wilderness Character Affected Environment

The majority of GCNP backcountry including the Inner Canyon, North Rim forests, and Kanab Plateau qualify for Wilderness designation (Map 3.1). The Colorado River is identified as potential Wilderness due to existing motorized raft use. Potential Wilderness includes 234 miles along the Colorado River from approximately 0.1 miles downstream of the historic Navajo Bridge at Colorado River Mile 4.2 to Separation Canyon at mile 239.8. Below Separation Canyon, the Wilderness boundary is on the north back of the river and extends to the LAKE boundary. The Cross-Canyon Corridor including Phantom Ranch and a one-mile section of the Colorado River are excluded from the Wilderness recommendation. (NPS 1980, updated 2010).

The 1980 GCNP Final Wilderness Recommendation awaits Congressional action. NPS 2006 Management Policies (Chapter 6, NPS 2006a) requires that NPS "will take No Action that would diminish the Wilderness eligibility of an area possessing Wilderness Characteristics until the legislative process of Wilderness designation has been completed. Until that time, management decisions will be made in expectation of eventual Wilderness designation. This policy also applies to potential Wilderness, requiring it to be managed as Wilderness to the extent that existing non-conforming conditions allow."

Further, DO-41, Wilderness Management, requires management decisions be consistent with MRA. When determining minimum requirement, potential disruptions of Wilderness Character and resources will be considered. MRA applies to all administrative activities. GCNP has established MRA protocols to document decisions related to administrative activities.

Defining Wilderness Character
Congressional intent for the meaning of Wilderness Character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act.

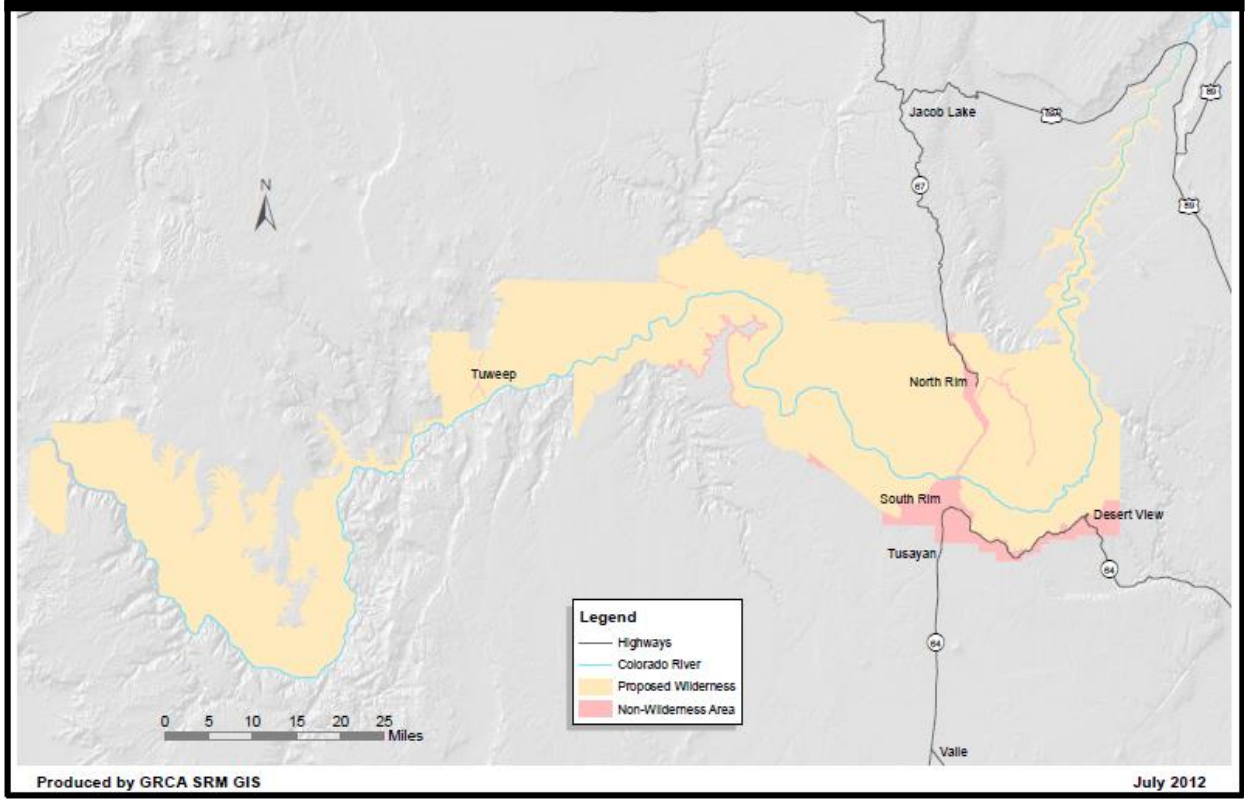
Subsection 2(c) of the Wilderness Act defines Wilderness as

> "A Wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

The same subsection 2(c) further defines Wilderness as having

- Undeveloped land retaining its primeval character in influence without permanent improvements or human habitation
- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation
- May contain ecological, geological, scientific, educational, scenic, or historical value

Map 3.1 Grand Canyon National Park Wilderness



This EA adopts definitions and concepts developed through an interagency process to establish a framework for monitoring conditions related to Wilderness Character (Landres et al. 2008). All Wilderness areas, regardless of size, location, or any other feature are unified by the statutory definition. These four qualities of Wilderness are

- **Untrammeled** – Wilderness is essentially unhindered and free from modern human control or manipulation. This quality pertains to actions that manipulate or control components of ecological systems
- **Natural** – Wilderness ecological systems are substantially free from effects of modern civilization. This quality pertains to intended and unintended human-caused effects on natural resource conditions
- **Undeveloped** – Wilderness is essentially without permanent improvements or modern human occupation. This quality pertains to presence of temporary or permanent scientific installations and facilities and use of motorized equipment and transportation within the proposed Wilderness
- **Outstanding opportunities for solitude or a primitive and unconfined type of recreation** – Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation. This quality pertains to visitor opportunities to experience a primitive setting and remoteness from sights and sounds of people and recreational structures within the Wilderness

Environmental Consequences

Methodology Wilderness Character

Baseline information used to assess impacts to Wilderness Character is described in Methodology at the beginning of Chapter 3, and includes park staff resource and site knowledge, review of existing literature and plans and studies, information provided by NPS and other agency specialists, and professional judgment. Additional sources of information on Wilderness Character used for this evaluation are described in Affected Environment. In addition, a MRA was completed to ensure management decisions affecting Wilderness are consistent with the Minimum Requirement Concept.

Under each Alternative, effects to Wilderness are addressed through description of impacts to the four qualities of Wilderness Character. The following table outlines indicators and measures used in this EA to determine impacts of fisheries management actions on Wilderness Character.

Table 3.3 Wilderness Character Indicators and Measures

Quality	Indicator	Measure
Untrammeled Wilderness essentially unhindered and free from modern control or manipulation	Actions in GCNP that manipulate the biophysical environment Actions outside GCNP or unauthorized actions that manipulate the biophysical environment**	1. Number of electro-fishing occurrences 2. Number of translocations
Natural Wilderness ecological systems substantially free from effects of modern civilization	Aquatic species and communities	1. Abundance, distribution or number of native species listed as threatened and endangered, sensitive or of concern 2. Number of extirpated species 3. Number of non-native species
Undeveloped Wilderness retains primeval character and influence, and essentially without permanent improvement or modern human occupation	Non-recreational structures, installations and developments Use of motorized vehicles/boats, equipment; mechanical transport	1. Number of scientific or administrative installations 2. Type and amount of motorized/mechanized transportation and equipment use
Solitude or Primitive and Unconfined Recreation Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation	Remoteness from sights and sounds of people in Wilderness	1. Number of encounters 2. Extent and magnitude of intrusions on natural soundscape 3. Extent and magnitude of intrusions on night sky visibility

** Actions outside GCNP are addressed in Cumulative Effects

Intensity Thresholds **Wilderness Character**

Negligible Wilderness Character unaffected or changes in character and qualities below or at level of detection. Visitors not likely aware of effects associated with the Alternative

Minor Changes in Wilderness Character and qualities detectable, although changes slight and in limited areas of Wilderness. Some visitors aware of effects associated with the Alternative, but effects would be slight and unnoticed by most visitors

Moderate Changes in Wilderness Character and qualities readily apparent and in limited areas of Wilderness. Visitors aware of effects associated with the Alternative and might express an opinion about the changes

Major Changes in Wilderness Character and qualities readily apparent, and may be severely adverse or exceptionally beneficial. Visitors aware of effects associated with the Alternative, and likely express a strong opinion about the changes

Duration Short term Temporary effect that largely disappears over a period of hours or days
Long term Effect that lasts months or years

Context Site-specific impacts affect small areas of Wilderness, where the specific action occurs, while local impacts occur across park Wilderness, but not beyond park boundaries

Alternative 1 No Action Environmental Consequences
Wilderness Character
Direct and Indirect Impacts
Actions performed under the No Action Alternative are ongoing and implemented under previously completed compliance and MRA.

Alternative 1 No Action Environmental Consequences
Wilderness Character
GCNRA
Glen Canyon Reach recreational trout fishery management would continue. The Colorado River is not in GCNRA proposed Wilderness, and Alternative 1 would not affect Wilderness Character. GCD operations would continue to impact river corridor resources and Glen Canyon Wilderness qualities, and are considered under Cumulative Effects.

Alternative 1 No Action Environmental Consequences
Wilderness Character
GCNP
Proactive native fish restoration would not occur in GCNP tributaries or the Colorado River. Alternative 1 may result in changes to existing Wilderness Character due to loss of indigenous fish species.

Conservation measures developed to mitigate impacts to HBC related to GCD, including expanded brown trout control at Bright Angel Creek, future HBC translocations, tributary rainbow trout control, and actions developed to meet HBC recovery criteria would not be implemented without additional planning and compliance. Extirpated species would not be reintroduced, although feasibility studies may occur.

Emergency responses for controlling new invasions of non-native fish or ANS or expanded populations of existing non-native species may be taken.

Untrammeled: monitoring native fish involving electro-fishing, netting, and handling in Shinumo and Havasu Creeks would continue. Impacts to the untrammeled quality of Wilderness Character would be short term, minor, local, adverse.

Natural**:** discontinuation of non-native fish removal (unless captured during monitoring) and discontinuation of translocations in Shinumo and Havasu Creeks may result in a decline in native fish population. Impacts to natural quality of Wilderness Character would be long term, moderate, local, adverse.

Undeveloped –Number and type of installations, and motorized equipment and motorized/mechanized transportation would remain unchanged. Impacts to the undeveloped quality of Wilderness Character would be short term, minor, local, adverse.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation **–N**umber of encounters with administrative trips along the river and backcountry areas would result from two or three monitoring trips to Shinumo and Havasu Creeks. Noise disturbance from electro-fishing equipment and motorized rafts would also occur. Impacts to the Wilderness experience would be local, short term, minor, adverse.

Alternative 1 No Action Environmental Consequences
Wilderness Character
Cumulative Effects
Cumulative Effects on Wilderness Character were assessed by combining impacts of Alternative 1 with the following other past, present, and reasonably foreseeable actions that have impacts in areas where fisheries management activities occur

- USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
- GCD LTEMP EIS (USBR, NPS in progress) for operation of GCD
- GCNRA General Management Plan (1979)
- Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
- GCNP Final Wilderness Recommendation (NPS 1980, 1993, 2010)
- GCNP BMP EA (NPS 1988)
- GCNP CRMP EIS (NPS 2006b)

The Cumulative Effects of past, present, and reasonably foreseeable actions, resulting Wilderness Character impacts to GCNRA would be negligible, and for GCNP could be local to regional, short and long term, moderate, adverse to Wilderness Character from presence of fisheries management crews, use of mechanized equipment in and adjacent to proposed Wilderness, maintenance of backcountry trails and campsites, fire management activities, aircraft overflights, and actions taken to manage releases from GCD.

Alternative 1 No Action Environmental Consequences
Wilderness Character
Conclusion
Minor to moderate adverse impacts to untrammeled and natural qualities would result from electro-fishing and monitoring activities and decline of native species due to discontinuation of translocations. Minor adverse impacts to undeveloped quality would result from presence of scientific equipment in the backcountry and continued use of motorized/mechanized transportation and equipment. Minor adverse impacts to the Wilderness Character would result from encounters with science crews and noise associated with motorized/mechanized equipment operations. Minor beneficial impacts to visitor

experience may result from increased education opportunities related to fish and endangered species management. Implementing Alternative 1 may contribute moderate adverse effect to Cumulative Effects of other past, present, and reasonably foreseeable future actions.

Alternative 2 Moderate Intensity Management Environmental Consequences
Wilderness Character
Direct and Indirect Impacts

Alternative 2 Moderate Intensity Management Environmental Consequences
Wilderness Character
GCNRA

Management of the Glen Canyon Reach recreational trout fishery would continue. The Colorado River is not in GCNRA proposed Wilderness, and would not affect overall Wilderness Character. Experimental stocking of tripoid/sterile rainbow trout is intended to improve recreational trout fishery quality. GCD operations would continue to impact river corridor resources and Glen Canyon Wilderness qualities and are considered under Cumulative Effects.

Alternative 2 Moderate Intensity Management Environmental Consequences
Wilderness Character
GCNP

Alternative 2 activities associated with native fish restoration, and potential outcomes of these efforts, would impact Wilderness Character similar to Alternative 1 with varying level of intensity and duration.

Conservation measures developed to mitigate GCD impacts to HBC including expanded brown trout control at Bright Angel Creek, future HBC translocations, tributary rainbow trout control, and actions developed to meet HBC recovery criteria would be implemented. Extirpated species may be reintroduced, but only following feasibility studies and additional planning and compliance. Only feasibility studies would be conducted under Alternative 2. Emergency response for controlling new invasions of non-native fish or other ANS may be taken. Proactive control of other species including catfish and bass would not be undertaken as in Alternative 3.

Untrammeled: Non-native fish control by electro-fishing would occur in the Colorado River, Shinumo and Bright Angel Creeks. HBC translocations involving fish handling and PIT-tagging would occur for two more years in Shinumo and Havasu Creeks, with occasional augmentation of translocated populations according to genetics management planning described in Chapter 2. Razorback sucker sonic tagging and monitoring would occur in the Colorado River below Lava Falls FMZ. Impacts to the untrammeled quality of Wilderness Character would be local, long-term, minor, adverse.

Natural**:** Non-native fish removal and continuation of native fish translocations would increase the native fish population. Effects of management actions may result in local, long-term, moderate, beneficial impacts to the natural quality of Wilderness Character.

Undeveloped – The number and type of installations for monitoring would be the same as Alternative 1. Use of motorized/mechanized equipment for electro-fishing would increase from Alternative 1, and number of trips requiring motorized/mechanized transportation (boat or helicopter) would increase due to additional monitoring, translocations, and mainstem electro-fishing, including management activities involving night work during the non-motorized use period. Impacts to the undeveloped quality of Wilderness Character would be local, short term, moderate, adverse.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: **N**umber of encounters with administrative trips along the river and in backcountry areas would increase compared to Alternative 1 due to additional monitoring, translocation, and mainstem work. Noise disturbance from electro-fishing equipment and motorized rafts would also increase over Alternative 1, due to mainstem activity, potential for helicopter use for translocations, and use of lights during night electro-fishing in the non-motorized use period. Impacts to Wilderness experience would be local short term moderate adverse.

Alternative 2 Moderate Intensity Management Environmental Consequences
Wilderness Character
Cumulative Effects

Cumulative Effects on Wilderness Character were assessed by combining impacts of Alternative 2 with the following past, present, and reasonably foreseeable actions with impacts in areas where fisheries management activities occur

- USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
- GCD LTEMP EIS (USBR, NPS in progress) for operation of GCD
- GCNRA General Management Plan (1979)
- Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
- GCNP Final Wilderness Recommendation (NPS 1980, 1993, 2010)
- GCNP BMP Plan EA (NPS 1988)
- GCNP CRMP Plan EIS (NPS 2006b)

Cumulative Effects of past, present, and reasonably foreseeable actions, resulting Wilderness Character impacts to GCNRA would be negligible, and for GCNP, could be local to regional, short term, moderate adverse to untrammeled, undeveloped and experiential qualities of Wilderness Character from presence of fisheries management crews, use of motorized/mechanized equipment in and adjacent to proposed Wilderness, maintenance of backcountry trails and campsites, fire management activities, aircraft overflights, and actions taken to manage releases from GCD. Actions taken to improve native fish populations may result in long-term minor beneficial impacts to the natural quality of Wilderness Character in light of other past, present and reasonably foreseeable actions.

Alternative 2 Moderate Intensity Management Environmental Consequences
Wilderness Character
Conclusion

Minor adverse impacts to the untrammeled quality would result from electro-fishing and monitoring activities. Moderate adverse impacts to undeveloped quality would result from presence of scientific equipment in backcountry and continued use of motorized/mechanized transportation and equipment, especially during the non-motorized period. Moderate adverse impacts to Wilderness Character would result from encounters with science crews and noise associated with motorized/mechanized equipment operations including night operations in Bright Angel FMZ. Moderate beneficial impacts to Wilderness Character would result from native fish restoration, and to visitor experience from increased education opportunities related to fish and endangered species management. Alternative 2 may contribute a moderate adverse cumulative effect with other past, present, and reasonably foreseeable future actions.

Alternative 3 Intensive Management Environmental Consequences
Wilderness Character
Direct and Indirect Impacts
GCNRA
Glen Canyon Reach recreational trout fishery management would continue. The Colorado River corridor is not in GCNRA proposed Wilderness, and would not affect overall Wilderness Character. Proposed experimental stocking of tripoid/sterile rainbow trout under Alternative 3 is intended to improve quality of recreational trout fishery. GCD operations would continue to impact river corridor resources and GCNP Wilderness qualities and are considered under Cumulative Effects.

Alternative 3 Intensive Management Environmental Consequences
Wilderness Character
GCNP
Under Alternative 3, activities associated with native fish restoration, and potential outcomes of these efforts would impact Wilderness Character similar to Alternative 1 with varying levels of intensity and duration.

Conservation measures developed to mitigate impacts to HBC related to GCD, including expanded brown trout control at Bright Angel Creek, future HBC translocations, tributary rainbow trout control, and actions developed to meet HBC recovery criteria would be implemented. Extirpated species may be reintroduced following feasibility studies, and additional planning and compliance. Emergency response for controlling new invasions of non-native fish or other ANS may be taken. Proactive control of other species including catfish and bass would be undertaken.

Untrammeled: Non-native fish control by electro-fishing would occur in the Colorado River, Shinumo and Bright Angel Creeks, and by netting in Havasu Creek. HBC translocations involving fish handling and PIT-tagging would occur for two more years in Shinumo and Havasu Creeks. RBZ sonic tagging and monitoring would occur in Lava Falls FMZ. Impacts to the untrammeled quality of Wilderness Character would be local, short term, minor adverse.
Natural**:** Non-native fish removal and continuation of native fish translocations would increase native fish populations. Effects of management actions may result in local, long-term moderate beneficial impacts to natural quality of Wilderness Character, possibly at a slightly higher degree than in Alternative 2.

Undeveloped –Number and type of monitoring installations would be the same as Alternatives 1 and 2. Use of motorized/mechanized equipment for electro-fishing would increase at Shinumo Creek, and number of trips requiring motorized/mechanized transportation (boat or helicopter) would increase due to additional monitoring, translocations, and mainstem electro-fishing, including management activities involving night work during the non-motorized use period. Impacts to undeveloped quality of Wilderness Character would be local, short term moderate adverse.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation –Number of encounters with administrative trips along the river and in backcountry areas would slightly increase compared to Alternative 2 due to additional monitoring, translocation, and mainstem work. Noise disturbance from electro-fishing equipment and motorized rafts would also increase over Alternative 2, due to mainstem activity and potential for helicopter use for translocations. Activities involving night work would occur twice each year, and once during the non-motorized use period. Impacts to Wilderness experience would be local short term moderate adverse.

Alternative 3 Intensive Management Environmental Consequences
Wilderness Character
Cumulative Effects

Cumulative Effects on Wilderness Character were assessed by combining impacts of Alternative 3 with the following ther past, present, and reasonably foreseeable future actions with impacts in areas where fisheries management activities occur

- USBR Non-native Fish Control EA and Experimental Releases from GCD, 2008 through 2012 EA (both 2012)
- GCD LTEMP EIS (USBR, NPS in progress) for operation of GCD
- GCNRA General Management Plan (1979)
- Bright Angel Creek Trout Reduction Project EA (NPS 2006c)
- GCNP Final Wilderness Recommendation (NPS 1980, 1993, 2010)
- GCNP BMP EA (NPS 1988)
- GCNP CRMP EIS (NPS 2006b)

Cumulative effects of past, present, and reasonably foreseeable actions, resulting Wilderness Character impacts to GCNRA would be negligible, and for GCNP could be local to regional, short term, moderate adverse to the untrammeled, undeveloped and experiential qualities of Wilderness Character from presence of fisheries management crews, use of mechanized/motorized equipment in and adjacent to proposed Wilderness, maintenance of backcountry trails and campsites, fire management activities, aircraft overflights, and actions taken to manage releases from GCD. Actions taken to improve native fish populations may result in long-term minor beneficial impacts to the natural quality of Wilderness Character in light of other past, present and reasonably foreseeable actions.

Alternative 3 Intensive Management Environmental Consequences
Wilderness Character
Conclusion

Minor adverse impacts to the untrammeled quality would result from electro-fishing and monitoring activities. Moderate adverse impacts to undeveloped quality would result from presence of scientific equipment in backcountry and continued use of motorized/mechanized transportation and equipment, especially during the non-motorized period. Moderate adverse impacts to Wilderness Character would result from encounters with science crews and noise associated with motorized equipment operations including night operations in the Colorado River portion of the Bright Angel FMZ. Moderate beneficial impacts to Wilderness Character would result from native fish restoration, and to visitor experience from increased education opportunities related to fish and endangered species management. Alternative 3 may contribute a moderate adverse impact to Cumulative Effects with other past, present, and reasonably foreseeable future actions.

NON-FISH SPECIAL STATUS WILDLIFE SPECIES

Affected Environment

The Endangered Species Act of 1973, as amended (16 USC 1531 et seq.), requires the NPS identify and manage federally listed threatened or endangered species and habitat, and consult with the USFWS prior to planning or implementing park projects that may affect these species and or their habitat. This is done to ensure the project does not jeopardize continued existence of federally listed or proposed threatened or endangered species or proposed critical habitat for that species. Protection of special status wildlife species is also mandated under NPS 2006 Management Policies (Section 4.4.2.3, NPS 2006a), GCNRA's 1979 General Management Plan, and GCNP's 1995 General Management Plan.

This section addresses non-fish special status wildlife, those species that have declined to the point where further declines could result in their eradication from GCNP and/or GCNRA or their extinction. These species are sensitive to small population fluctuations where loss of populations or individuals could have substantial repercussions. Special status fish species are discussed in Chapter 3, Fisheries.

Across all Alternatives, field work proposed actions would occur along the mainstem Colorado River and some tributaries in GCNP and the Glen Canyon Reach of GCNRA. The only interaction with wildlife outside the river and tributary corridors would occur as a result of movement of personnel and equipment to project work sites. Under all Alternatives, this transport would occur by motorized and non-motorized raft, helicopter, automobile on established roads, and foot (according to MRA). Most foot travel would take place on established trails, although some off-trail travel would occur. Most camping would occur in established campgrounds such as at Lees Ferry and Phantom Ranch, although occasional camping could occur outside established campgrounds in established backcountry camps on the river. Expected disturbance to special status wildlife species, would come as the result of disturbance from noise and/or the presence of field crews. Habitat disturbance would be minimal. Some local trampling of riparian vegetation could occur.

Table 3.4 lists non-fish federally threatened and endangered species known to occur in the project area. Consultation with USFWS is currently taking place and detailed discussions of federally listed species that may be affected by the proposed actions are subjects of a separate Biological Assessment (Palarino and Healy 2013).

Table 3.4 GCNP Federally Threatened and Endangered Species

Name	Species	Status
Wildlife		
California condor	*Gymnogyps californianus*	Endangered Experimental Non-Essential (10j) population designated for Southwest Reintroductions Considered Threatened in National Parks within 10j Area
Humpback chub*	*Gila cypha*	Endangered
Kanab ambersnail	*Oxyloma haydeni kanabensis*	Endangered
Mexican spotted owl*	*Strix occidentalis lucida*	Threatened
Desert tortoise	*Gopherus agassizii*	Threatened
Razorback sucker*	*Xyrauchen texanus*	Endangered
Relict leopard frog	*Rana onca*	Candidate
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered
Western yellow-billed cuckoo	*Coccyzus americanus*	Candidate
Yuma clapper rail	*Rallus longirostris yumanensis*	Endangered
Plants		
Sentry milk-vetch	*Astragalus cremnophylax cremnophylax*	Endangered

*Species with designated critical habitat in GCNP

Non-Fish Special Status Wildlife Species **Affected Environment**

Federally Listed Species That May Be Affected

California Condor

The California condor was listed as an endangered species in March 1967 (USFWS 1967, 32 FR No.48; 4001). In 1996, the third revision to the USFWS Recovery Plan modified previous recovery strategies that

focused primarily on habitat protection, to emphasize the captive breeding program and intensive efforts to reestablish the species in the wild (USFWS 1996a). Following that revision, USFWS established a "nonessential, experimental population" (10j) of California condors in northern Arizona delineated by a 10j boundary in northern Arizona and southern Utah (USFWS 1996b). In December 1996, the first condors were reintroduced in the Vermilion Cliffs area of Coconino County, Arizona, approximately 30 miles (48 kilometers) north of GCNP. Subsequent releases have occurred 1997- 2012 in the same vicinity and Hurricane Cliff area, about 60 miles west of Vermilion Cliffs. The AZGFD lists the California condor as a Species of Special Concern; however, in GCNP and other national parks within the 10j area, the condor has the full protection of a threatened species.

Condors are members of the New World vulture family, feeding exclusively on carrion such as deer, cattle, rabbits, and large rodents. Using thermal updrafts, condors can soar at up to 50 miles per hour and travel 100 miles or more per day, reaching altitudes of 15,000 feet to seek food while expending little energy. California condors typically forage in open terrain, although in GCNP foraging does occur in forested areas on deer and elk carcasses. Typical foraging behavior includes long-distance reconnaissance flights, lengthy circling flights over a carcass and hours of waiting at a roost or on the ground near a carcass. When not foraging, condors spend most of their time perched at a roost. Cliffs, tall conifers, and snags serve as roost sites (USFWS 1996a).

Condors are long-lived species with low reproductive rates, living up to 60 years in the wild, and become sexually mature at six or seven years of age. Condors create nests in rock formations such as caves, crevices, and potholes (USFWS 1996a). Courtship begins in December, and breeding pairs lay a single egg between late January and early April. Eggs hatch after approximately 56 days, and young condors take their first flight at approximately six months. Young condors may be dependent on parents through the following breeding season (USFWS 1996a). Without the guidance of their parents, young, inexperienced juveniles may also investigate human activity. As young condors learn and mature, this human-directed curiosity diminishes.

Little information exists to document precise causes of condor decline, but reasons were probably diverse. A main cause was an unsustainable mortality rate of free-flying birds combined with a naturally low reproductive rate. Most deaths in recent years have been related to human activity. Shootings, poisonings, lead poisoning, and power line collisions are considered the condor's major threats. In GCNP, the leading cause of mortality has been lead poisoning from foraging on carcasses shot with lead ammunition.

Non-Fish Special Status Wildlife Species **Affected Environment**

Federally Listed Species That May Be Affected

Condors at GCNP

As of October 2012, the Arizona population of wild condors is 77. All northern Arizona condors are fitted with radio transmitters allowing field biologists to monitor their movements. In GCNP, California condor nesting habitat is generally limited to cliffs and caves in the Redwall Limestone of the Inner Canyon. Based on GPS location point data, condors have been documented flying, perching, and nesting throughout GCNP with concentrations of activity at South Rim and Marble Canyon areas. Condors are active year-round at South Rim and Marble Canyon; however, a growing number of condors typically begin visiting the Marble Canyon portion of the Colorado River corridor in February, March, and April (NPS 2005). Condors are at rim level less frequently in winter and are more often seen along the river corridor during this time.

California condor nesting habitat at GCNP is limited to Inner Canyon cliffs and caves. The first nesting attempt in the park was confirmed in 2001 in the Marble Canyon area. Condors have nested in GCNP every year since. The first wild-reared chick in the program's history, and likely the first chick in Arizona in 100 years, fledged November 2003. Since then, seven chicks have fledged in the park.

Non-Fish Special Status Wildlife Species **Affected Environment**
Federally Listed Species That May Be Affected
Condors at GCNRA

In GCNRA, California condors are rare local permanent residents with most activity occurring between GCD and Navajo Bridge (Spence et al. 2011). The first nesting attempt in GCNRA was confirmed in 2012 in the Glen Canyon Reach.

Non-Fish Special Status Wildlife Species **Affected Environment**
Federally Listed Species That May Be Affected
Mexican Spotted Owl

The Mexican spotted owl (MSO) was listed as a threatened species in March 1993 (USFWS 1993, 58 FR 14248) and portions of GCNP were designated as critical habitat in February 2004 (USFWS 2004b, 69 FR 53182). A MSO Recovery Plan was first published in December 1995, and was recently revised (USFWS 2012b). Six Recovery Units were identified in the original Recovery Plan to allow for specific recovery strategies for each area. In the plan revision, Recovery Units have been renamed Ecological Management Units (EMU); GCNRA and GCNP are located in the Colorado Plateau EMU. Federal lands account for 46% of this EMU and, of the documented MSO sites recorded in this EMU, 64% have been located on NPS lands (USFWS 2012b).

MSO are known to occur in Arizona, New Mexico, southern Utah, portions of Colorado, and Mexico and are typically associated with late seral forests. MSO are generally found in habitat that includes mixed conifer and pine-oak forests, riparian madrean woodland, and sandstone canyonlands (USFWS 1995a). However, MSO have been found in relatively open shrub and woodland vegetation communities in arid canyonland habitat (Ganey 1988), contrary to the typical mature forest habitat believed to be the classic norm.

MSO nest and roost sites are primarily in closed-canopy forests or rocky canyons. Breeding occurs March to August annually. Females normally lay one to three eggs, two being the most common (Gutiérrez et al. 2003). Forests used for roosting and nesting often contain mature or old growth stands with complex structure. These forests are typically uneven-aged, multistoried, and have high canopy closure. MSO do not build nests, but use naturally occurring sites, often in large diameter trees, cliff cavities, and abandoned hawk or raven nests. Protected Activity Centers (PAC), determined using several detection criteria, encompass about 600 acres surrounding known owl sites and are intended to protect the activity center of a single owl territory (USFWS 2012b).

Spotted owls are primarily nocturnal and prey mainly on small mammals, particularly arboreal or semi arboreal species. Birds, insects, reptiles, and other types of small mammals are taken as well; prey species composition varies with cover type. MSO are known to occur in cool canyon habitat in GCNP defined as low thermal intensity, short thermal duration, and steep slopes (Spotskey and Willey 2000).

GCNP MSO presence was confirmed in 1992 through field surveys. To understand distribution and abundance, the park initiated inventory for spotted owls in both forest and rocky canyon habitats in the mid-1990s. MSO individuals (60 individuals) have been located, and a total 40 MSO PACs exist in GCNP covering 30,285 acres. The average size per PAC at GCNP is 757 aces. The 40 PACs have been found below the rims in side canyons; however, owls have been located on the canyon's rims as well. To date, the number of acres of MSO canyon nest/roost potential habitat determined from predictive models stands at 1,860 acres (Spotskey and Willey 2000).

Data analysis and field observations indicate roost and nest sites are located toward canyon heads and in the Redwall Limestone geologic layer (Bowden 2008). These areas are shady and generally include some

tree and shrub vegetation. No roost or nest sites have been found above the rim on the forested plateau of North or South Rim. MSO were infrequently found foraging on the North Rim plateau within two miles of the side canyon used for nesting or roosting. MSO were also observed (i.e., responding to calls) on North and South Rims during surveys (Bowden 2008).

The primary threat cited for MSO recovery in most EMUs (as updated in the 2012 Recovery Plan) is large-scale catastrophic stand-replacement wildfire. Threats from predation, disease, parasites and starvation, accidents, and potential interactions of threat factors with climate change are considered comparatively minor to stand-replacement wildfire (USFWS 2012b). Potential threats cited specifically for the Colorado Plateau EMU focus more on recreational impacts, road building, and overgrazing.

Non-Fish Special Status Wildlife Species **Affected Environment**

Federally Listed Species That May Be Affected

Southwestern Willow Flycatcher

The southwestern willow flycatcher (SWFL) is one of four currently recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993). It is a neotropical migrant that breeds in the southwestern U.S. and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948; Stiles and Skutch 1989; Peterson 1990; Ridgely and Tudor 1994; Howell and Webb 1995). On March 29, 1995 SWFL was designated as endangered (USFWS 1995b, FR 60, No.38, 10694) in its entire range, known to include Arizona, California, Colorado, New Mexico, Texas, Utah, and Mexico.

In August 2002, the USFWS released the Final Recovery Plan for the Southwestern Willow Flycatcher. The Recovery Plan establishes six recovery units further subdivided into Management Units. These Recovery and Management Units are based on watershed and hydrologic units in the flycatcher's breeding range (USFWS 2002b). GCNRA and GCNP fall in the Lower Colorado Recovery Unit. This Recovery Unit encompasses the Colorado River and its tributaries from GCD downstream to the Mexican border. Despite the large size of this Recovery Unit, the unit contains only 146 known territories (15% of the range-wide total) (USFWS 2002b).

The SWFL breeds in dense riparian habitats from sea level in California to approximately 8,500 feet in Arizona and southwestern Colorado. Throughout its range the SWFL arrives on breeding grounds in late April and May (Sogge and Tibbitts, 1992; Sogge et al., 1993; Sogge and Tibbitts, 1994; Muiznieks et al., 1994; Maynard, 1995; Sferra et al., 1995, 1997). Nesting begins in late May and early June, and young fledge from late June through mid-August (Willard, 1912; Ligon, 1961; Brown, 1988a, b; Whitfield, 1990; Sogge and Tibbitts, 1992; Sogge et al., 1993; Muiznieks et al., 1994; Whitfield, 1994; Maynard, 1995). The entire breeding cycle, from egg laying to fledging, is approximately 28 days. Nesting occurs spring and early summer (May 1st through August 31st) in GCNP.

Historical egg/nest collections and species descriptions throughout its range identify the SWFL's widespread use of willow (*Salix* spp.) for nesting (Phillips 1948, Phillips et al. 1964, Hubbard, 1987, Unitt 1987, San Diego Natural History Museum 1995). Other habitats are also used, including non-native species such as tamarisk (*Tamarix spp.*) and Russian olive (*Eleagnus angustifolia*). Throughout the SWFL's current range, suitable riparian habitats tend to be rare, widely separated small and/or linear locales separated by vast expanses of arid lands.

In GCNP, 17 flycatcher sites were identified in the 2002 Recovery Plan (USFWS 2002b). Flycatcher territories in GCNP are generally located in the tamarisk-dominated riparian vegetation along the river corridor but not in the mesquite-acacia and hackberry-dominated habitats higher on the slopes (Sogge et al. 1997). The flycatcher's nesting habitat is dynamic in that it varies in occupancy, suitability, and location over time.

GCNP historic and recent nesting site locations have been documented below Lees Ferry in Marble Canyon and lower Grand Canyon below Diamond Creek (RM 225.5 – 277). There have been no SWFL nests or nesting behavior identified in the Inner Gorge (RM 77.9 – RM 116.5); however, migrant birds have been documented. Because river channels, river flows, and floodplains are varied and can change over time, location and quality of nesting habitat may also change over time. In GCNP, this is especially noticeable in the lower Grand Canyon where dropping Lake Mead levels have resulted in high walls (10 to 20 feet high in many areas) of sediment topped with tamarisk bordering the Colorado River. Backwaters and saturated soils preferred by SWFL have become difficult to find.

Numbers of SWFL detections in GCNP have declined since the 1980s. There is little information on SWFL number along the river before GCD construction. However, available data suggests SWFL were not common breeders along the Colorado River in GCNP (Brown 1988a; Brown 1991; Sogge et al. 1997).

The SWFL has experienced extensive loss and habitat modification and is endangered by other factors, including brood parasitism by brown-headed cowbird (*Molothrus ater*; USFWS 1995b). The SWFL was listed primarily due to riparian habitat reduction, degradation, and elimination as a result of agricultural and urban development. Other reasons for decline/vulnerability include: the fragmented distribution and low numbers of the current population; predation; and other events such as fires and floods that are naturally occurring, but have become more frequent and intense as a result of proliferation of exotic vegetation and degraded watersheds, respectively. The recent introduction, spread, and effect of tamarisk-eating leaf beetle, threatens SWFL by defoliating and killing nesting habitat (Arizona Ecological Services Field Office 2011).

In GCNRA, southwestern willow flycatcher's are uncommon restricted migrants in riparian situations, rare summer residents, and probable breeders (Spence et al. 2011).

Non-Fish Special Status Wildlife Species **Affected Environment**

Federally Listed Species That May Be Affected

Yuma Clapper Rail

The Yuma clapper rail was listed as endangered on March 11, 1967 (32 Federal Register 4001). A five-year species review was completed in 2006, and currently the 1983 Recovery Plan is in the revision process. Although the majority of the population is found in Mexico, the Yuma clapper rail is only listed as endangered in the U.S. It is categorized as a subspecies with a high degree of threat and low recovery potential due to habitat loss that has to be actively managed. The Yuma clapper rail occurs along the lower Colorado River (downstream of RM 234) and tributaries (Virgin, Bill Williams, Lower Gila Rivers) in Arizona, California, Nevada, and Utah; the Salton Sea in California; and the Cienega de Santa Clara and Colorado River Delta in Mexico (USFWS 2009). Between 2000 and 2008 the number of Yuma clapper rails in the U.S. has fluctuated between 503 and 890 (USFWS 2009). Significant breeding areas include Mittry Lake (AZ), Imperial Reservoir, Imperial National Wildlife Refuge, Bill Williams River National Wildlife Refuge, Topock Gorge and Topock Marsh in Havasu National Wildlife Refuge, Cibola National Wildlife Refuge, Imperial Wildlife Area, Sonny Bono Salton Sea National Wildlife Refuge, and the Cienega de Santa Clara.

The Yuma clapper rail is a secretive species and is not often seen in the wild; however, it does have a series of distinctive calls and is most often identified by those. This bird inhabits freshwater or brackish stream sides and marshes under 4,500 feet in elevation. It is associated with dense riparian and marsh vegetation, dominated by cattails (*Typha* sp.) and bulrush (*Scirpus* ssp.) with a mix of riparian tree and shrub species. Yuma clapper rails may climb into a shrub or tree, but overall they do not perch above the ground (USFWS 2009). Clapper rails are capable of swimming and are also known to dive underwater,

and may hold onto submerged vegetation to avoid threats or use its wings to swim (Todd 1986, Ripley 1977 cited in Eddleman and Conway 1998). The clapper rail requires a wet substrate such as a mudflat, sandbar, or slough bottom that supports cattail stands of moderate to high density adjacent to shorelines. Other important factors are presence of vegetated edges between marshes and shrubby riparian habitat (tamarisk or willow thickets) and amount and rate of water level fluctuations. Nests are built three to six inches above the surface in sloughs and backwaters that support dense stands of bulrush and cattails, and breeding occurs March to early July. Along the lower Colorado River males begin calling in February and pair bonding occurs shortly after. Non-native crayfish provide the primary food base for the clapper rail today. Prior to crayfish introduction, isopods, aquatic and terrestrial insects, clams, plant seeds, and small fish likely dominated their diet (USFWS 2004).
Eddleman (1989) determined vocalizations are significantly reduced in winter, and telemetry data indicated the majority of clapper rails do not migrate. There is evidence some populations may be more migratory than others and this could be based on habitat and a stable food source (Eddleman 1989, Corman and Wise-Gervais 2005). Very little is known about dispersal of adult or juvenile birds, but there is evidence of populations expanding northward along the lower Colorado River, Salton Sea, and central Arizona over the last 80 years (USFWS 2004b).

Marsh bird surveys were conducted in 2009 by the Lower Colorado River Multi-Species Conservation Program along portions of the lower Colorado River, adjacent backwaters, lakes, and marshes (Kahl 2009). The portion of GCNP included in the Lower Colorado River Multi-Species Conservation Program (RM 234 to 277) was not included in these surveys.

Yuma clapper rails were recorded at GCNP 1996 to 2001; however, information about the clapper rail and its habitat in the lower Grand Canyon is extremely limited and surveys have not been conducted in the park in recent years.

McKernan and Braden (1999) reported the presence of Yuma clapper rails between Spencer Canyon (RM 246) and the GCNP boundary (RM 277); these observations were made while conducting SWFL surveys. In 2001, three individual Yuma clapper rails were observed near Burnt Springs by San Bernardino College (pers. comm. San Bernardino College to Elaine Leslie, 2001).

Habitat is present in a very limited quantity in lower Grand Canyon. Koronkiewicz et al. (2004) and McLeod et al. (2005) report presence of live cattails at Spencer Canyon (RM 246) and Burnt Springs (RM 259.5). Cattail were observed as part of SWFL habitat observations Spencer Canyon to the western GCNP boundary. It is not known if such habitat is present in sufficient quantity to allow nesting.

Due to limited information about the clapper rail and its habitat in the lower Grand Canyon, and lack of surveys in recent years, GCNP must rely heavily on limited information available. Given that Yuma clapper rails have been recorded historically at GCNP but not surveyed consistently or recently, GCNP presumes the clapper rail may be present in the lower Grand Canyon during the lifetime of this CFMP.

Non-Fish Special Status Wildlife Species **Affected Environment**

Federally Listed Species That May Be Affected

Western Yellow-Billed Cuckoo

The future of the western yellow-billed cuckoo (*Coccyzus americanus*), a neotropical migrant that breeds throughout northern Mexico, the U.S., and southern Canada, is uncertain (Hughes 1999). Western yellow-billed cuckoo populations have declined throughout the species' range (Hughes 1999); western populations, in particular, have decreased and suffered catastrophic range reductions in the 20th Century (Laymon and Halterman 1987; Hughes 1999; Corman and Magill 2000). In 2001 the USFWS determined the western yellow-billed cuckoo represents a distinct population segment and concluded federal listing was warranted, but the action was precluded by higher priority listing actions and the species became a

Candidate Species under the ESA (USFWS 2001, FR66, 143: 38611). California lists the western yellow-billed cuckoo as endangered (CDFG 1978), and Arizona lists it as a species of special concern (AZGFD 1988). Probable factors believed to contribute to population declines are the loss, fragmentation, and alteration of native riparian breeding habitat, possible loss of wintering habitat, and pesticide use on breeding and wintering grounds (Corman and Magill 2000).

The western yellow-billed cuckoo is a late migrant associated with large tracts of riparian deciduous forest where willow, cottonwood, sycamore, or alder occur. Cuckoos begin arriving in Arizona and California in late May (Bent 1940, Hughes 1999). Nesting usually occurs late June to late July, but can begin as early as late May and continue to late September (Hughes 1999), and may be triggered by an abundance of cicadas, katydids, caterpillars, or other large prey which form the bulk of the species' diet (USFWS 2001).

Yellow-billed cuckoos' secretive nature and infrequent calling, together with large home ranges and short nesting period make them challenging to study (Laymon et al. 1997, Hamilton and Hamilton 1965, Halterman 2008). Cuckoos have the shortest nesting cycle among birds, a minimum of 16 days between egg and fledging (Payne 2005). In addition to these difficulties, cuckoos often display avoidance behavior or avoid moving when surveyors are observed. Telemetry observations in 2009 and 2010 show many cuckoos detected are transitory and do not stay on-site long (McNeil et. al 2010).

The Lower Colorado River Multi-Species Conservation Program covers areas in the Colorado River's historical floodplain from Lake Mead (specifically RM 234) to the United States-Mexico Southerly International Boundary, a distance of about 400 river miles (Lower Colorado River Multi-Species Conservation Program 2004a). Developed between 1996 and early 2005, the Lower Colorado River Multi-Species Conservation Program includes creation of more than 8,100 acres (3,278 hectares) of riparian, marsh, and backwater habitat for six listed species and 21 other species native to the Lower Colorado River including at least 4,050 acres (1,639 ha) of habitat for the riparian obligate yellow-billed cuckoo (Lower Colorado River Multi-Species Conservation Program 2004a).

Habitat is very limited in lower Grand Canyon. Based on detections prior to 1998, suitable nesting habitat may be present in the upper portion of the project area; however, surveys have been extremely limited to date in lower Grand Canyon, and non-existent in the upper river corridor, and their failure to detect nesting cuckoos does not indicate definitively that the species is not present in GCNP.

Within **GCNRA**, the western yellow-billed cuckoo is a rare restricted transient in dense riverside tamarisk thickets (Spence et al. 2011).

Environmental Consequences

Methodology **Non-Fish Special Status Wildlife**

Baseline information used to assess impacts to special status species is as described in Methodology at the beginning of this chapter, and includes park staff knowledge of resources and site, review of existing literature and park studies, information provided by NPS and other-agency specialists, and professional judgment. Detailed information on GCNP natural and cultural resources in the 1995 GMP EIS was specifically referenced for information on affected resources in the project area.

Intensity Thresholds **Non-Fish Special Status Wildlife**

Negligible	Impacts to individuals, their habitat, or ecosystem processes not affected, or effects not measureable.

Minor Impacts to individuals, their habitat, or ecosystem processes perceptible or measurable, but severity and timing of changes to parameter measurements not expected to be outside natural variability and have no effects at the population level, including distributions or behaviors of special status species. Impacts outside critical periods.

Moderate Impacts to individuals or a population of special status species, their habitat, or ecosystem processes perceptible and measurable, and severity and timing of changes to parameter measurements expected sometimes outside natural variability. Measureable changes occur from natural variability on species' populations including numbers, structure, distributions, behaviors, genetic variability, or other demographic factors. Some impacts affect critical periods, key habitat, ecosystem processes, or activities necessary for survival, but effects are temporary and populations are expected to return to pre-disturbance conditions, and remain indefinitely stable and viable. No species at risk of being extirpated from the park.

Major Impacts to special status species or their habitat measurable, and severity and timing of changes to parameter measurements expected to be outside natural variability for long periods or even be permanent; changes wittin natural variability might be long term or permanent. Populations of special status species might have large declines, with population numbers significantly depressed. In extreme cases, a species might be at risk of being extirpated from the park, key ecosystem processes like nutrient cycling might be disrupted, or habitat for any species might be rendered not functional. Substantive impacts occur during key time periods. Impacts long term to permanent.

Type of Impact

Adverse Impacts adversely affect size, continuity, or integrity of individual or populations of special status species or habitat outside normal range of variability, move habitat areas away from desired conditions, or impede normal breeding, foraging, or resting behavior or lead to a loss of nesting, foraging, or dispersal habitat. Other examples are events that could result in direct mortality, temporal or spatial displacement of wildlife from habitat, habitat fragmentation, or reduction of habitat quality

Beneficial Impacts positively affect size, continuity, or integrity of individual or populations of special status species or habitat, move habitat areas toward desired conditions, enhance normal breeding, foraging, or resting behavior or lead to an increase in nesting, foraging, or dispersal habitat

Duration

Short term One year or less for an individual or habitat; three years or less for a population

Long term Greater than one year for an individual or habitat; greater than three years for a population

Context

Regional Impacts affect a widespread area of suitable habitat or the range of the population or species. If species only occur in one area and that entire area is affected, impact is considered regional since it impacts the entire population of the special status species.

Localized Impacts confined to a small part of the population, habitat or range

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected

The following activities will continue under Alternative 1

- Projectwide outreach/aquatic invasive species introduction prevention
- Emergency response to new/expanded populations
- Minimal removal of fish, incidental to monitoring
- Angler harvest regulations
- No actions in Bright Angel Creek and Inflow after March 2013
- Havasu and Shinumo Creeks HBC monitoring

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Direct and Indirect Effects
Under Alternative 1, current fisheries management, monitoring, and research would continue in GCNP and in the Glen Canyon Reach. Monitoring efforts in Havasu and Shinumo Creeks would result in impacts from helicopter noise disturbance, field crew presence, and some vegetation trampling.

These activities could impact special status wildlife species and mitigation measures developed in the project-specific Biological Assessment, and Best Management Practices (Chapter 2) would be followed to minimize impacts to special status wildlife species that could result from current management activities.

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Mexican Spotted Owl
NPS fisheries management activities have potential to impact MSO through direct noise disturbance by helicopters and field crews. MSO critical habitat occurs primarily in remote backcountry on North Rim in mixed-conifer forests and below the rim in side canyons where mechanized equipment would not be used. There may be specific instances over the life of the plan where field crews will access Havasu Creek via helicopter to monitor translocated HBC. Helicopter transport would avoid areas of known and potential MSO nesting and roosting habitat to ensure potential for noise impacts are minimized.

Implementation of Alternative 1 would result in negligible, long-term, localized impact to MSO.

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
California Condor

California condor nesting habitat is generally limited to Inner Canyon cliffs and caves. The main concern with California condors in relation to implementing the selected Alternative is potential contact with humans. Condors are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity, such as Grand Canyon Village on South Rim. Noise and activity associated with fisheries management activities have potential to attract condors to work and campsites, and can increase potential for interaction between condors and humans. Field crews would generally be small groups with limited potential to disturb or attract condors. Condor contact with humans would be of concern if the birds became habituated to humans. Mitigation measures to educate work crews on condor concerns, and to cease activities if condors are present, would reduce potential disturbance from management activities on the birds. There may be specific instances over the life of the plan where field crews will access Havasu Creek via helicopter to monitor translocated HBC. Helicopter transport would avoid areas of known and potential condor nesting sites to ensure potential for noise impacts are minimized.

Implementation of Alternative 1 would result in negligible long-term localized impact to condors.

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Southwestern Willow Flycatcher, Yuma Clapper Rail, and Western Yellow-Billed Cuckoo

The SWFL, Yuma clapper rail, and western yellow-billed cuckoo have been known to use riparian habitats in close proximity to or along the Colorado River in GCNP and GCNRA. These birds may be disturbed by increased human-generated noise during the breeding season; however, locations of current management activities have not been identified as breeding locations for these species.

Alternative 1 would result in negligible long-term localized impact to SWFL, Yuma clapper rails, and western yellow-billed cuckoos.

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Cumulative Effects

Past, present, and reasonably foreseeable future actions impacting special status wildlife species include GCD operations, other fish management projects, and recreational use.

GCD operations have moderate, adverse, regional, long-term impacts on special status wildlife species. Other fish management projects including USBR non-native fish removal in the mainstem of the Colorado River (USBR 2012b) have negligible, localized, long-term impacts on these species. Finally, recreational use of the river and recreational fishing has minor, adverse, regional, long-term impacts from noise disturbance and vegetation trampling.

Alternative 1 No Action Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Conclusion

Continuation of current fisheries management activities under Alternative 1 would result in negligible, long-term, localized impacts from noise disturbance and vegetation trampling. Cumulative Effects of

Alternative 1 in combination with past, present, and reasonably foreseeable future actions would be minor, adverse, long-term, regional.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected

This Alternative emphasizes restoration of native fish communities primarily through HBC translocation and other native species and uses some non-native fish control, more than Alternative 1, but less than Alternative 3. It includes

- Continue outreach efforts to prevent accidental or purposeful introduction of new non-native aquatic species in the project area. Outreach efforts would also encourage harvest of all non-native fish species by anglers
- Translocate HBC from LCR to tributaries outside the LCR and mainstem. A remote PIT-tag antenna would be maintained at Shinumo and Bright Angel Creeks (if trout control objectives are met, and translocations occur) to monitor outmigration of translocated HBC
- Implement a comprehensive mechanical removal (netting, electro-fishing, weir use, angling) program for trout in and around Bright Angel Creek
- Respond to emergencies of new non-native species introductions requiring immediate action using mechanical removal means
- Implement control of non-native species in tributaries, focusing efforts on areas where translocations occur
- Remove and euthanize all high-risk, non-native predatory fish species captured during monitoring efforts, unless specific research objectives designed to improve efficiency of control efforts warrant tagging and release including brown trout (*Salmo trutta*), catfish species (including bullheads), bass and sunfish (Centrarchidae), striped bass (Moronidae), cichlids (Cichlidae), perch and walleye (Percidae), and other rare non-native species not previously detected in GCNP or the Glen Canyon Reach
- Targeted volunteer angling trips to remove trout from Marble Canyon
- Translocations of native fish (bluehead sucker) to tributaries if declines occur related to non-native fish control using electro-fishing
- Beneficially use non-native fish removed, according to results of consultation with Traditionally Associated Indian Tribes under NHPA Section 106
- Experimentally stock sterile, triploid, rainbow trout in the Glen Canyon Reach to maintain angling opportunities if a severe decline in rainbow trout occurs
- Implement an adaptive management approach to management or augmentation of razorback sucker in Lower Colorado River FMZ (downstream of Lava Falls to the Lake Mead Inflow). This includes sonic-telemetry studies of adults released below Lava Falls, increased sampling of larval or small-bodied fish to better assess RBS current status, and implementation of a monitoring and augmentation plan, if determined appropriate based on results of studies and in consultation with USFWS and Lake Mead Razorback Working Group

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Direct and Indirect Effects
Fisheries management activities under Alternative 2 would result in impacts to special status wildlife species from noise disturbance, field crew presence, and vegetation trampling.

Mitigation measures in project-specific Biological Assessment and Chapter 2's Best Management Practices would be followed to minimize impacts to special status wildlife species that could result from Alternative 2.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Mexican Spotted Owl

Fisheries management activities under Alternative 2 have potential to impact MSO through noise disturbance associated with activity near known owl locations in side canyons as well as helicopter flights carrying live fish for translocations, staff, and project equipment.

Proposed Alternative 2 activities would take place along GCNP mainstem Colorado River and in tributaries. There is potential for these activities to occur near MSO nest/roost areas. Field crews may also need to travel through these areas to get to a project site; however, it is expected crews will use established trails and therefore will not contribute measureable disturbance to MSO when compared to current conditions.

MSO seem to prefer GCNP's habitat of steep canyons below the rim. This suggests helicopters would often be obscured from MSO, but high canyon walls may also amplify sound and echo it in specific locations. Helicopters would be used for transporting live fish in GCNP, staff, and project equipment to various Inner Canyon locations. There is potential for direct noise disturbance to MSO; however, conservation measures to minimize potential for noise disturbance to MSO during the breeding season would be followed. These conservation measures are currently implemented at GCNP.

Determination of noise impacts on MSO is difficult, but based on distance helicopters maintain from PAC boundaries, the short-term duration of noise, and that MSO and helicopters would not occupy the same air space simultaneously, Alternative 2 would result in negligible to minor, adverse, long-term, localized impacts to MSO.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
California Condor

Potential impacts under Alternative 2 to California condors would be attraction to project areas during fisheries management activities, and noise disturbance from helicopter flights in and out of the canyon transporting live fish in GCNP associated with translocations, staff, and project equipment.

The main concern with California condors is potential for contact with humans. Condors are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity. The noise and activity associated with management activities has potential to attract condors to project sites and can increase potential for interaction between condors and humans. Fisheries crews would generally consist of small groups of four to eight people. Conservation measures to educate work crews on condor concerns, and to cease activities if condors are present, would reduce potential disturbance from management activities on the birds. To date, condors have not been attracted to or observed in close proximity to NPS fisheries projects.

California condor nesting and roosting habitat is generally limited to Inner Canyon cliffs and caves. Proposed activities will take place along GCNP mainstem Colorado River and tributaries. There is potential for these activities to occur near condor nest/roost areas. Field crews may need to travel through

these areas to get to a project site; however, it is expected crews will use established trails and therefore will not contribute measureable disturbance to condors when compared to current conditions.

Helicopters would be used for transporting live fish, staff, and project equipment to various Inner Canyon locations. There is potential for direct noise disturbance to condors; however, conservation measures to minimize potential for noise disturbance to condors during the breeding season would be followed. These conservation measures are currently implemented at GCNP.

Based on distance helicopters and work crews would maintain from known roost/nest sites, and short-term duration of noise, Alternative 2 would result in negligible to minor, adverse, long-term, localized impacts to California condors.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Southwestern Willow Flycatcher, Yuma Clapper Rail, and Western Yellow-Billed Cuckoo
Impacts to SWFL, Yuma clapper rails, and western yellow-billed cuckoos would be focused on the river/riparian habitat which constitutes the species' potential, suitable, and existing breeding areas. These birds may be disturbed due to increased human-generated noise during the breeding season. Fisheries management activities have potential for increased noise from field crews traveling through areas to get to project sites; however, established trails and campsites would be used, and therefore, impacts would not be measureable above current conditions. Proposed activities are water-based but could impact some shoreline vegetation (trampling) and cause some noise disturbance.

Alternative 2 would result in negligible to minor adverse, long-term, localized impacts to SWFL, Yuma clapper rails, and western yellow-billed cuckoos.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Cumulative Effects
Past, present, and reasonably foreseeable future actions impacting special status wildlife species include GCD operations, other fish management projects, and recreational use.

GCD operations have moderate, adverse, regional, long-term impacts on special status wildlife species. Other fish management projects including USBR non-native fish removal in the Colorado River mainstem have negligible, adverse, localized, long-term impacts on these species. Recreational river use and recreational fishing has minor, adverse, regional, long-term impacts from noise disturbance and vegetation trampling.

Alternative 2 Moderate Intensity Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Conclusion
Proposed fisheries management activities under Alternative 2 would result in negligible to minor, adverse, long-term, localized impacts from noise disturbance and vegetation trampling. Cumulative Effects of Alternative 2 in combination with past, present, and reasonably foreseeable future actions would be minor, adverse, long-term, regional.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected

This Alternative emphasizes a more intensive or proactive native fish community restoration than the prior Alternatives, primarily through a series of non-native fish control efforts and native fish translocations. In addition to actions previously mentioned in Alternative 2, this Alternative includes

- A higher removal rate for incidental captures of high-risk predators caught during monitoring including common carp
- Targeted and proactive control of warm-water non-native fish congregations at areas including the Little Colorado Inflow, Havasu Creek and the Colorado River near the mouth of Havasu and Kanab Creeks, and areas of the river below Lava Falls. Anglers below Diamond Creek would remove catfish. It is possible that several thousand additional fish could be removed under this action
- An additional non-native trout removal trip for Bright Angel Creek (two trips/year)
- Geographic expansion including 1.9 additional miles (3 additional kilometers) of stream for Shinumo Creek trout control; possibly doubling amount of trout removed and area impacted by field crews

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Direct and Indirect Effects
Alternative 3 fisheries management activities would have similar impacts to special status wildlife species as Alternative 2 from noise disturbance, field crew presence, and vegetation trampling.

Mitigation measures developed in the project-specific Biological Assessment and Chapter 2's Best Management Practices would be followed to minimize impacts to special status wildlife species that could result from Alternative 3.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Mexican Spotted Owl
Proposed fisheries management activities under Alternative 3 have potential to impact MSO through noise disturbance associated with activity near known owl locations in side canyons and helicopter flights carrying live fish, staff, and project equipment.
Proposed activities would take place along the mainstem Colorado River and in tributaries in GCNP. There is potential for these activities to occur near MSO nest/roost areas. Field crews may need to travel through these areas to get to a project site; however, it is expected crews will use established trails and therefore would not contribute measureable disturbance to MSO when compared to current conditions.

MSO seem to prefer GCNP's habitat of steep canyons below the rim. This suggests helicopters would often be obscured from MSO, but high canyon walls may also amplify sound and echo it in specific locations. Helicopters would be used for transporting live fish, staff, and project equipment to various Inner Canyon locations. There is potential for direct noise disturbance to MSO; however, conservation measures to minimize potential for noise disturbance to MSO during the breeding season would be followed. These conservation measures are currently implemented at GCNP.

Determination of noise impacts on MSO is difficult, but based on distance helicopters would maintain from PAC boundaries, short-term noise duration, and that MSO and helicopters will not occupy the same air space simultaneously, Alternative 3 would result in negligible to minor, adverse, long-term, localized impacts to MSO.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
California Condor

Potential impacts to California condors would be attraction to project areas during fisheries management activities, and noise disturbance from helicopter flights in and out of the canyon transporting live fish, staff, and project equipment.

The main concern with California condors is potential for contact with humans. Condors are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity. Noise and activity associated with fisheries management activities has potential to attract condors to project sites and can increase potential for interaction between condors and humans. Fisheries crews would generally consist of small groups of four to eight people. Conservation measures to educate work crews on condor concerns, and to cease activities if condors are present, would reduce potential disturbance from management activities on the birds. To date, condors have not been observed near NPS fisheries projects.

California condor nesting and roosting habitat is generally limited to Inner Canyon cliffs and caves. Proposed activities would take place along GCNP's mainstem Colorado River and tributaries. There is potential for these activities to occur near condor nest/roost areas. Crews may need to travel through these areas to get to a project site; however, it is expected crews would use established trails and therefore would not contribute measureable disturbance to condors compared to current conditions.

Helicopters would be used to transporting live fish, staff, and project equipment to various Inner Canyon locations as in Alternative 2; however, there would be a slight increase of helicopter use at Shinumo Creek under Alternative 3. There is potential for direct noise disturbance to condors; however, conservation measures to minimize potential for noise disturbance to condors during the breeding season would be followed. These conservation measures are currently implemented at GCNP.

Based on distance helicopters and work crews would maintain from known roost/nest sites, and short-term noise duration, Alternative 3 would result in minor, adverse, long-term, localized impacts to California condors.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Southwestern Willow Flycatcher, Yuma Clapper Rail, and Western Yellow-Billed Cuckoo

Impacts to SWFL, Yuma clapper rails, and western yellow-billed cuckoos would focus on the river/riparian habitat which constitutes the species' potential, suitable and existing breeding areas. These birds may be disturbed due to increased human-generated noise during the breeding season. Fisheries management activities have potential for increased noise from field crews traveling through areas to get to project sites; however, established trails and campsites would be used, and therefore, impacts would not be measureable above current conditions. Proposed activities, such as targeted and proactive control of warm-water non-native fish congregations are water-based but would impact some shoreline vegetation (trampling) and cause noise disturbance.

Alternative 3 would result in minor adverse, long-term, localized impacts to SWFL, Yuma clapper rails, and western yellow-billed cuckoos.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Cumulative Effects
Past, present, and reasonably foreseeable future actions impacting special status wildlife species include GCD operations, other fish management projects, and recreational use.

GCD operations have moderate, adverse, regional, long-term impacts on special status wildlife species. Other fish management projects including USBR non-native fish removal in Colorado River mainstem have negligible, adverse, localized, long-term impacts on these species. Recreational river use and recreational fishing has minor, adverse, regional, long-term impacts from noise disturbance and vegetation trampling.

Alternative 3 Intensive Management Environmental Consequences
Non-Fish Special Status Wildlife Species
Federally Listed Species That May Be Affected
Conclusion
Alternative 3 would result in minor, adverse, long-term, localized impacts primarily from noise disturbance and vegetation trampling. Cumulative Effects of Alternative 3 in combination with past, present, and reasonably foreseeable future actions would be minor, adverse, long-term, regional.

CHAPTER 4 CONSULTATION AND COORDINATION

INTRODUCTION

Chapter 4 describes consultation and coordination during EA preparation. Consultation, coordination, and public involvement are integral in identifying relevant issues and concerns and to ensure issues are addressed. Formulation of issues was achieved through internal scoping, agency and tribal meetings, and individual comments.

Internal Scoping Consultation and Coordination

Scoping identifies resources potentially affected by a proposed project, and explores possible ways of achieving actions while minimizing adverse impacts. Internal scoping was conducted by an interdisciplinary team of professionals from GCNP and GCNRA. Several Interdisciplinary Team Members (IDT) meetings occurred throughout 2012 to discuss project purpose and need; goals and objectives; Alternatives; potential environmental impacts; past, present, and reasonably foreseeable projects (see Chapter 3) that may have Cumulative Effects; and possible mitigation measures. The IDT also gathered background information, available data, and discussed public outreach. Meeting discussions with IDT members were considered and documented in this EA.

External Scoping Consultation and Coordination

External scoping was conducted to inform the public about CFMP development for waters between GCD and Lake Mead in GCNP and GCNRA and to generate input on EA preparation. This effort began in June 2012 when scoping information was e-mailed to over 1,000 individuals. In addition, scoping information was sent to Traditionally Associated American Indian Tribes, and state and federal agencies. In addition, the scoping letter and press release were posted on the NPS Planning, Environment, and Public Comment website. A press release was sent to local news organizations. The public was given 30 days to comment, ending June 30, 2012. Recipients were asked to respond with issues or concerns related to fish management.

During the external public scoping period, approximately 57 pieces correspondences from general public, fishing advocacy groups, fishing guides, tribal, and state and federal agencies (one federal agency, five state agencies and one Tribe) were received through PEPC postings and letters.

Issues and concerns raised during scoping include

- Support for recreational fishing in the Glen Canyon reach
- Support for local economic benefits in the Glen Canyon reach
- General support for the EA
- Support for efforts to maintain and restore both the recreational fishery and native fish
- Statements that the plan should be integrated with the Long Term Experimental and Management Plan (LTEMP) Environmental Impact Statement
- Statements that the Comprehensive Fish Management Plan should be delayed until the LTEMP process in completed

NPS used this scoping response, in combination with input from the project interdisciplinary team and other NPS staff, American Indian Tribes, the Arizona Department of Game and Fish, U.S. Fish and Wildlife Service, and Bureau of Reclamation to re-evaluate project purpose, need, and objectives. Based on this, NPS developed a preliminary project proposal designed to best meet the purpose and need for action and specific project objectives.

Agency Consultation **Consultation and Coordination**

In addition to public scoping, Federal agencies are required to consult with American Indian tribes and federal, state and local agencies with jurisdiction or special expertise applicable to the proposed action.

Tribal Consultation **Consultation and Coordination**

In keeping with provisions of NEPA, Section 106 of the National Historic Preservation Act of 1966 as amended, NPS 2006 Management Policies (Section 5.2.1, NPS 2006a), and Executive Orders 13007 and 13175, opportunities for government-to-government consultations with American Indian tribes were provided throughout CFMP EA development.

The following tribes, all traditionally associated with Grand Canyon National Park and/or Glen Canyon National Recreation Area, were provided opportunities to consult on CFMP EA development

- Havasupai Tribe
- Hopi Tribe
- Hualapai Tribe
- Kaibab Band of Paiute Indians
- Las Vegas Paiute Tribe
- Moapa Band of Paiute Indians
- Navajo Nation
- Paiute Indian Tribe of Utah
- Pueblo of Zuni
- San Juan Southern Paiute Tribe
- Ute Mountain Ute Tribe
- Yavapai-Apache Nation

Tribal consultations and information sharing related to GCNP's Fisheries Program have been ongoing for several years related to, and in preparation for, EA development. GCNP has consulted with tribes on humpback chub translocations in Shinumo and Havasu Creeks, and Bright Angel Creek weir and trout control. In addition, GCNP sends copies of all fisheries program field trip reports to tribes via email and has invited tribes to comment at any time or to request consultation. Meetings separate from EA development on these other projects have been held with the Zuni Cultural Resource Advisory Team and Navajo Nation Historic Preservation Department staff. In addition, the GCNP Fisheries Program Manager was invited to and participated in the Navajo Nation's annual river monitoring trip to discuss NPS fisheries program activities. Activities specifically related to tribal consultation during EA preparation are shown in Table 4.1.

Table 4.1 Tribal Consultation

Consultation Event	Date	Tribe(s)	Description
Letter from Superintendent	March 30, 2010	11 tribes traditionally associated with GCNP	Introduction to GCNP fisheries program goals and activities with opportunity provided for collaboration/consultation*
Letter from Superintendent	June 15, 2012	12 tribes traditionally associated with GCNP/GCNRA	Scoping and invitation for government-to-government consultation under NEPA/NHPA
Follow-up emails and phone calls from GCNP tribal program and GCNRA cultural resource program managers	July 6-August 9, 2012	12 tribes traditionally associated with GCNP/GCNRA	Reminder of opportunity to consult offered in 6/15 letter. Information shared regarding proposed schedule and other consultation points. Feedback received from Navajo, Zuni, Hopi, Yavapai-Apache, and Ute Mtn. Ute
Meeting	September 20, 2012	Hopi Tribe	GCNP/GCNRA staff attended Hopi Cultural Preservation Office/Cultural Resource Advisory Team meeting and presented information on draft Alternatives and beneficial use
Meeting	October 25,	Zuni Cultural Resource	GCNP staff at Zuni to meet with ZCRAT to

Consultation Event	Date	Tribe(s)	Description
	2012	Advisory Team (ZCRAT)	discuss Alternatives, impacts, and beneficial use
Letter from GCNP/GCNRA Superintendents	November 14, 2012	12 tribes traditionally associated with GCNP/GCNRA	Discussion of draft Alternatives and preliminary Section 106 Finding of Effect
Email from GCNP Tribal Program Manager	April 16, 2013	12 tribes traditionally associated with GCNP/GCNRA	Current schedule, anticipated EA release mid-May, park is working on a Section 106 agreement document

Primary issues or concerns raised by tribes include

- Taking of life of fish in the Colorado River, with some areas (LCR confluence) being especially sensitive from the tribal perspective
- Whirling Disease (human and environmental safety concerns from diseased trout)
- Human fish consumption, and what may and may not be beneficial use

Arizona State Historic Preservation Office **Consultation and Coordination**

Section 106 of the National Historic Preservation Act of 1966 as amended, and its implementing regulations, require federal agencies to consider effects of undertakings on historic properties (resources determined eligible or listed on the National Register of Historic Places) and provide the State Historic Preservation Office (SHPO), Traditionally Associated American Indian Tribes, and as necessary, the Advisory Council on Historic Preservation (ACHP), a reasonable opportunity to comment. On August 6, 2012, the NPS sent a letter to the SHPO to initiate § 106 for the CFMP and request initial comments. The NPS sent another letter to SHPO dated November 8, 2012 seeking comments on draft Alternatives and the preliminary Section 106 Finding of Effect. No response was received.

Section 106 consultation with the SHPO, Traditionally Associated American Indian Tribes, and as necessary the ACHP, will continue through the CFMP process including consultation on this EA. As part of the consultation process for this EA, the NPS would continue to identify concerns, assess potential for cultural resources impacts, develop appropriate mitigation measures, and seek concurrence with the determination of effect. If there were adverse effects, the NPS would continue consultation to seek ways to avoid, minimize, or mitigate adverse effects on historic properties.

U.S. Fish and Wildlife Service and Arizona Game and Fish Department **Consultation and Coordination**

In accordance with the Endangered Species Act, NPS contacted the USFWS regarding federally listed special status species, and in accordance with NPS policy, GCNP also contacted AZGFD regarding state-listed species.

Prior to drafting this EA, the NPS consulted informally with USFWS about related fisheries management actions to preserve and restore native fish in GCNP, and resulting effects to threatened and endangered fish and other species.

The NPS has maintained continuous consultation with USFWS since CFMP EA inception. This includes formal consultation, phone conversations, emails, workshops, and meetings. USFWS personnel were present, along with GCNP, GCNRA, and AZGFD staff at two meetings to develop actions for managing the recreational fishery and native fish in the Glen Canyon reach and for managing endangered and other native fish in GCNP.

On June 1, 2012 NPS sent a letter to USFWS to initiate discussions on the CFMP EA. On June 27, 2012 USFWS submitted initial comments and suggestions. Issues and species discussed during on-going

consultations were considered when developing Alternatives, affected environment, and environmental consequences.

A draft Biological Assessment was submitted to USFWS for this EA on December 14, 2012.

The AZGFD has been participating and assisting GCNRA and GCNP in development of fisheries management strategies for this planning effort beginning in 2010. This participation includes site visits, meetings, emails, and phone conversations. NPS fisheries management goals and objectives were developed in consultation with AZGFD.

Environmental Assessment Review and List of Recipients Consultation and Coordination

The EA is subject to a 30-day public comment period. To inform the public of EA availability, NPS will publish and distribute a press release to its e-mail list and mail letters to various agencies and tribes. The document will be available for review on the PEPC website at http://parkplanning.nps.gov/GCNP. Copies will be provided to interested individuals on request.

During the 30-day public review period, the public is encouraged to submit written comments to NPS, as described in the instructions at the beginning of this document. Following the close of the comment period, all public comments will be reviewed and analyzed prior to the release of a decision document. The NPS will issue responses to substantive comments received during the public comment period, and will make appropriate changes to the EA as needed.

List of Preparers Consultation and Coordination

The following persons assisted and/or consulted with during EA preparation.

Table 4.2 NPS Personnel Who Contributed To or Reviewed this Document

Name	Title	Responsibility/Contribution
Grand Canyon National Park		
Brian Healy	Fisheries Program Manager	Project Lead, preparer
Janet Balsom	Deputy Chief, Science and Resource Management	Project oversight and review
Rachel Bennett	Environmental Protection Specialist	Prepared sections and reviewed
Jill Beshears	Environmental Protection Specialist	Prepared sections and reviewed
Ellen Brennan	Cultural Resources Program Manager	Cultural Resource Lead, prepared and reviewed cultural resource sections
Rebecca Carr	Environmental Protection Specialist	Reviewed and edited
Greer Chesher	Editor	Entire Document
Janet Cohen	Tribal Program Manager	Tribal Consultation Lead, prepared and reviewed ethnographic resource and tribal consultation sections
Deanna Greco	Physical Science Program Manager	Prepared and reviewed physical science sections
Martha Hahn	Chief, Science and Resource Management	Project oversight and review
Greg Holm	Wildlife Program Manager	Prepared and reviewed wildlife sections
Linda Jalbert	Outdoor Recreation Planner	Prepared visitor experience and Wilderness Character sections
Catherine Lentz	Environmental Protection Specialist	Section 106 Coordinator, review
Lori Makarick	Vegetation Program Manager	Prepared and reviewed vegetation sections

Name	Title	Responsibility/Contribution
Rosa Palarino	Natural Resource Specialist, Section 7 Coordinator	Compliance Lead, prepared sections and reviewed
Clay Nelson	Fisheries Biologist	Assisted in Alternative development
Emily Omana Smith	Fisheries Biologist	Assisted in Alternative development
Jane Rodgers	Deputy Chief, Science and Resource Management	Reviewed sections
Melissa Trammell	NPS-Intermountain Region Fisheries Biologist	Assisted in Alternative development, edited and reviewed EA
Charlie Repath	Restoration Ecologist	Prepared sections
Glen Canyon National Recreation Area		
Mark Anderson	Aquatic Ecologist	Reviewed and edited EA
Rosemary Sucec	Chief, Branch of Cultural Resources	Reviewed and edited EA
Teri Tucker	Chief of Planning and Compliance	Reviewed and edited EA
Chris Hughes	Chief, Science and Resource Management	Reviewed and edited EA
Steve Henry	Wilderness Program Manager	Reviewed and edited EA
Todd Brindle	Superintendent	Reviewed and edited EA

ACRONYMS

ADEQ	Arizona Department of Environmental Quality
AIS	Aquatic Invasive Species
ANS	Aquatic Nuisance Species
ASMR	Age-structured Mark-recapture Method
AZGFD	Arizona Game and Fish Department
BMP	Backcountry Management Plan
BO	Biological Opinion
CIA	Cumulative Impact Analysis
CEQ	Council on Environmental Quality
CFMP	Comprehensive Fisheries Management Plan
CFR	Code of Federal Regulations
CRMP	Colorado River Management Plan
DCP	Development Concept Plan
DO	Director's Order
DOI	Department of the Interior
DPD	Discrete Population Segment
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMU	Ecological Management Units
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FMS	Flannelmouth Sucker
FMZ	Fish Management Zone
GCD	GCD
GCDAMP	GCD Adaptive Management Program
GCMRC	Grand Canyon Monitoring and Research Center
GCNRA	Glen Canyon National Recreation Area
GCNP	Grand Canyon National Park
GCPA	Grand Canyon Protection Act
GMP	General Management Plan
HBC	Humpback chub
HFE	High flow experiment
IDT	Interdisciplinary Team (GCNP)
km	kilometers
LAKE	Lake Mead National Recreation Area
LCR	Little Colorado River
LTEMP	Long-Term Experimental and Management Plan
LMRSWG	Lake Mead Razorback Sucker Working Group

m	meters
MRA	Minimum Requirement Analysis
MSO	Mexican spotted owl
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NNF	Non-native Fish
NRA	National Recreation Area
PAC	Protected Activity Centers
PBR	Paira River—Badger Canyon Reach
PEPC	Planning, Environment, and Public Comment website
PIT	Passive integrated transponder
RBS	Razorback Sucker
RM	River Mile
ROD	Record of Decision
SWFL	southwestern willow flycatcher
TWG	Technical Work Group
UDNR	Utah Division of Natural Resources
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
ZCRAT	Zuni Cultural Resource Advisory Team

GLOSSARY

Aggregation	A consistent and disjunct group of fish with no significant exchange of individuals with other aggregations, as indicated by recaptured of tagged juveniles and adults and movement of radio-tagged adults (Valdez and Ryel 1995)
Anthropogenic	Relating to, or resulting from the influence of human beings on nature.
Assemblage	A collection or community of plants or animals characteristically associated with a particular environment that can be used as an indicator of that environment
Backwater	Part of a river in which there is little or no current
Baseline	The beginning level against which future trends are measured
Basin (river)	The land area that drained by a river and/or tributary
Dominate	To exceed others in abundance or biomass; measured as density (fish per unit area) or grams per unit area (i.e., dominant species in a fish assemblage)
Colorado River Basin, Upper and Lower	USFWS-defined Colorado River Basin; Upper Basin Recovery Unit (above GCD) (USFWS 2002), and Lower Basin Recovery Unit (below GCD) (see Table 3.1).
Conservation Measure	Conservation measures are actions to benefit or promote the recovery of species listed under the Endangered Species Act that are included by the Federal agency as an integral part of the proposed action. These actions will be taken by the Federal agency, and serve to minimize or compensate for, project effects on the species under review. These may include actions taken prior to the initiation of consultation with the U.S. Fish and Wildlife Service, or actions which the Federal agency has committed to complete in a biological assessment or similar document.
Electro-fishing	A scientific fish-sampling technique that uses electricity to temporarily stun fish so they can be captured. Electro-fishing is a common scientific survey method to sample fish populations for abundance, density, and species composition. When performed correctly, electro-fishing results in no permanent harm to fish, which return to their natural state shortly after being effected by electro-fishing equipment
Enhanced Population	Recruitment or abundance increases from baseline
Extirpated	Local extinction, in which a species ceases to exist in a specific geographic area, though it still exists elsewhere
Food web	Feeding relationships of organisms in an ecosystem. Carnivorous (meat-eating) predators are at the highest level of a food web, while algae and plants are lower
Foodbase	Lower levels of organisms in the food web, generally including aquatic invertebrates in the context of this plan
Genetic Integrity	In terms of humpback chub genetics management, maintaining genetic integrity means establishing a reasonable approximation of a natural population, i.e., normal size and age distribution and gene flow established and maintained from the donor source
Glen Canyon Reach	For purposes of this CFMP EA, the Glen Canyon Reach is defined as the 15 miles downstream from GCD on the Colorado River in GCNRA, including Lees Ferry and the mouth of the Paria River (see Map 1.2)
Inflow	The area where a tributary stream or river flows into a larger body of water
Inflow Aggregation	Humpback chub aggregations (see definition above) existing in an inflow reach of the Colorado River, including the Little Colorado River Inflow, Bright Angel Creek Inflow, Shinumo Creek Inflow, and Havasu Creek Inflow
Large-bodied Fish	Species whose average adult size exceeds 150 mm (six inches) total length, i.e., rainbow and brown trout, bluehead sucker, flannelmouth sucker, common carp, channel catfish, humpback chub, etc.

GLOSSARY

Lower Basin Recovery Unit	Recovery unit for endangered or threatened species including the Lower Colorado River Basin from GCD downstream to the international boundary with Mexico.
Mature	For humpback chub, a fish is considered mature if in spawning condition (ripe, expressing gametes), or is greater than or equal to 200 mm (7.9 inches) total length, or is approximately four-years old
Minimum Viable Population	Minimum viable population as determined by USFWS. Currently for humpback chub, the minimum viable population is 2,100 adults (total length greater than 200 mm), but revisions are in process
PBR Reach	Paria—Badger Rapid Reach of the Colorado River in GCNP. The area of GCNP's Marble Canyon between the Paria River mouth and Badger Rapid (RM 0.9 – 7.9)
Recovery Criteria	Recovery and demographic criteria set by USFWS for downlisting or delisting species listed under the ESA
Recovery Plan	A document drafted by USFWS, National Oceanic and Atmospheric Administration Fisheries, or other knowledgeable individual or group, that serves as a guide for activities undertaken by Federal, State, or private entities in helping recover and conserve endangered or threatened species
Recovery Unit	A management sub-unit of the listed entity, geographically or otherwise identifiable, essential to the recovery of the entire listed entity; conserves genetic or demographic robustness, important life history stages, or other feature for long-term sustainability of the entire listed entity. Recovery units are optional, but, where used, should collectively encompass the entire listed entity. Recovery criteria for the listed entity should address each identified recovery unit, and every recovery unit must be recovered before the species can be delisted
Recruitment	Juveniles added to populations or aggregations through reproduction or dispersal/ translocation from other populations
Riparian	Pertaining to a river bank or banks of a wetland. Plants in this area are usually dependent on or influenced by the water table connected to the adjacent surface water body (lake, wetland, or stream)
Self-sustaining (Populations)	Recruitment exceeds adult mortality, maintaining populations with minimal or no management intervention
Translocation	The act of moving a group of fish from one location and releasing them in another
Weir	A fish trap system consisting of a trap and a fence to funnel fish into the trap

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APPENDIX A GCNP NATIVE FISH SPECIES

Common Name	Scientific Name	Status			
		Federal	State	Navajo**	Other
Flannelmouth sucker	*Catostomus latipinnis*	-	-	-	SC
Humpback chub	*Gila cypha*	E	WSC	G2	
Razorback sucker	*Xyrauchen texanus*	E	WSC	G2	
Colorado pikeminnow	*Ptychocheilus lucius*	E			EX
Bonytail	*Gila elegans*	E	WSC	G1	EX
Roundtail chub	*Gila robusta*	C (Colorado River lower basin)	WSC	G3	EX
Speckled dace	*Rhinichthys osculus*				
Bluehead sucker	*Catostomus discobolus*				

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Arizona Game and Fish Department. Heritage Data Management System. Accessed at: www.azgfd.gov/w_c/edits/species_concern.shtml
Species names conform to the Integrated Taxonomic Information System (ITIS). Accessed at: www.itis.gov

Federal Status

E Endangered, in danger of extinction
T Threatened, severely depleted
C Candidate for listing as threatened or endangered
D Delisted
XN Experimental, non-essential population; in Grand Canyon condors are managed as federally endangered

State Status

WSC Wildlife of Special Concern in Arizona
E Endangered, state listing
SR Listed as salvage restricted by the Arizona Department of Agriculture; the plant is subject to damage by theft or vandalism; a state permit and salvage fees required for removal

Navajo Endangered Species List

Group 1 (G1) No longer occurs on Navajo Nation lands. Arizona Game and Fish Department, 1996
Group 2 (G2) Prospect of survival or recruitment is in jeopardy
Group 3 (G3) Prospect of survival or recruitment is likely to be in jeopardy in the foreseeable future
** Navajo status determination is not used by any other affiliated Grand Canyon tribes

Other

EX Extirpated
SC Species of Concern. Some information showing vulnerability or threat, but not enough to support listing under the Endangered Species Act. Some of these species are former USFWS Category 1, 2, and 3 species (Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species)

APPENDIX B USFWS RECOVERY EXPLAINED

U.S. Fish & Wildlife Service

Endangered Species Recovery Program

Working with partners, the U. S. Fish and Wildlife Service (FWS) uses a range of conservation tools to "recover" endangered and threatened species—to ensure that they are able to survive on their own in the wild. These tools include restoring and acquiring habitat, removing invasive species, conducting surveys, monitoring individual populations, and breeding species in captivity to release them into their historic range.

Collaborative efforts are critical to recovery success. Our partners include Federal, State, and local agencies, Tribal governments, conservation organizations, the business community, landowners, and other concerned citizens.

As a result of these efforts, the Endangered Species Act (ESA) has been credited with saving species such as the California condor, black-footed ferret, peregrine falcon, and our Nation's symbol, the bald eagle, from extinction.

What do we mean by recovery?

Recovery is the process that stops the decline of an endangered or threatened species by removing or reducing threats. Recovery ensures the long-term survival of the species in the wild. At that point, the species is recovered, and protection of the ESA is no longer necessary.

How does the Recovery Program work?

The FWS Recovery Program staff works with our partners at other agencies, States and local governments, and FWS programs to implement actions that help prevent the extinction of species, and prepares, coordinates, and implements recovery plans.

Recovery plans provide a road map with detailed site-specific management actions for private, Federal, and State cooperation in conserving listed species and their ecosystems. A recovery plan is a non-regulatory document, but it provides guidance on how best to help listed species achieve recovery.

Chris Seal / USFWS

Nelson's checkermallow is a threatened species that has been reintroduced to the Baskett Slough National Wildlife Refuge pictured here.

How is species recovery achieved?

Recovering listed species cannot be accomplished solely on our national wildlife refuges, national forests, national parks, and other Federal lands because many species occur primarily or solely on private land. Achieving recovery for most species typically requires cooperative conservation with private landowners.

To stabilize, recover, and ultimately delist endangered and threatened species, the FWS engages a range of stakeholders.

Flexible management of threatened species

Section 4(d) of the ESA enables us to establish special regulations specifically for threatened species.

These "4(d)" or "special rules" allow us to customize the protections of the ESA to match the conservation needs of the species.

For example, the FWS developed a special rule to benefit the Apache trout, a species that anglers may catch while attempting to catch other fish. To accommodate the accidental capture, the rule allows Apache trout to be caught as long as they are returned to the water. Revenue generated from fishing in waters that the trout inhabits helps conserve habitat.

Safe Harbor Agreements for private landowners

The FWS provides opportunities for private landowners to participate in conserving and recovering imperiled species by offering incentives. One example is the Safe Harbor program, available to non-Federal landowners who voluntarily implement conservation measures for listed species. Safe Harbor Agreements allow landowners to do good things for endangered and threatened species without concern about additional restrictions or regulations.

In the Southeast, landowners who participate in Safe Harbor Agreements for red-cockaded woodpeckers have been removing hardwoods in longleaf

pine stands, conducting controlled burns to remove undergrowth, and installing nest boxes. These activities help address the loss of habitat and promote breeding success since the endangered birds would otherwise need years to excavate nesting cavities in living longleaf pine trees. Safe Harbor Agreements assure landowners that the FWS will not require them to do more for the woodpeckers, including those attracted to the improved habitat, thereby alleviating concern about future land use restrictions under the ESA.

Grants to States, Territories, and private landowners

The FWS also annually offers millions of dollars in grants for endangered species conservation and recovery. Cooperative Endangered Species Conservation Fund grants are offered to States and Territories for an array of projects to benefit species that are listed, proposed, or candidates for listing.

In turn, these funds may be awarded to private landowners and groups for conservation projects. For more on our grants programs, visit http://www.fws.gov/endangered/grants/.

Reintroducing species into their historic range

Re-establishing a threatened or endangered species in its former range is often necessary so that there are enough populations to sustain recovery. To relieve concern that reintroductions may result in restrictions on the use of private, tribal, or public land, Congress added the provision for experimental populations under section 10(j) of the ESA.

An experimental population is a group of reintroduced plants or animals that is geographically isolated from other populations of the species and is not considered essential to the survival of the species as a whole. Experimental populations are afforded additional regulatory flexibility regarding management of the species.

For example, the 10(j) rules for black-footed ferrets makes certain incidental harm to ferrets legal when it happens as a result of otherwise lawful activities including traditional management or land use.

This flexibility has allowed FWS biologists to introduce ferrets into a number of sites on public and private lands from Mexico to Canada. With the special allowances afforded under the 10(j) rule, landowners can continue to manage their lands without concern about breaking the law by inadvertently harming a ferret.

Paul Marinari / USFWS

The black-footed ferret has been bred in captivity and reintroduced into its natural habitat.

Through the captive-breeding program and the creation of 19 new populations, the number of black-footed ferrets has increased from only 18 ferrets in a captive-breeding program to more than 1000 animals in the wild.

Recovery efforts occur throughout the FWS

FWS programs are leading recovery efforts for species. For example, many of our national fish hatcheries are raising endangered or threatened species such as Higgins' eye pearly mussels at the Genoa National Fish Hatchery in Wisconsin. Many national wildlife refuges such as Florida's Hobe Sound were established to protect listed species such as green sea turtles and loggerhead turtles but also benefit a range of bird and plant species. The Partners for Fish and Wildlife program offers technical and financial assistance to private landowners to voluntarily restore wetlands and other habitat. The Partners program emphasizes the reestablishment of native vegetation and ecological communities for the benefit of fish and wildlife in concert with the needs and desires of private landowners. Our Law Enforcement program focuses on potentially devastating threats to wildlife by investigating wildlife crimes, regulating wildlife trade, helping us understand and obey wildlife protection laws, and working in partnership with international, State, and Tribal counterparts.

Who else helps to recover species?

Recovery cannot be completed without partners from all areas of land and species management. We rely on private landowners, Federal agencies, state and local governments, Tribes, and non-profit organizations to complete our recovery tasks.

We work with land managers to create management plans that accomplish their objectives while benefiting listed plants and animals. We engage private landowners through our Partners for Fish and Wildlife and Grant programs. Our state counterparts are pivotal in sharing location information and lessons learned. Captive breeding is often completed with the help of zoos or plant materials centers. And we rely on members of the academic community to share valuable new information that aids in our conservation of listed species.

The recovery of each listed species is a collaborative effort that involves numerous partners.

What are some examples of recovery efforts?

The Aleutian Canada goose has benefited from both habitat restoration and reintroduction into formerly occupied habitat. Translocating young bald eagles into formerly occupied habitat was one factor in recovering the species to the point of delisting. Captive propagation has increased the numbers of whooping cranes and red wolves. Land acquisition and cooperation among the FWS and the States have protected important habitats for Houston toads and other amphibians.

Do recovery programs work?

Yes, Since 1969, 99 percent of listed species have been prevented from going extinct through the efforts of the FWS Recovery program and our many partners. But the task of recovery can be very challenging for many species. We are attempting to halt or reverse declines that in some instances have been more than 200 years in the making. Even in the face of a substantial increase in the number of species listed during the past decade, recovery efforts have allowed rare species to survive and, in some cases, thrive.

U. S. Fish and Wildlife Service
Endangered Species Program
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http://www.fws.gov/endangered/what-we-do/recovery-overview.html

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